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ANEURYSM FOLLOWING SURGICAL PROCEDURES*
Report of Five Cases

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IT IS GENERALLY RECOGNIZED that trauma is the *usual* causal agent in the production of an arteriovenous fistula, and the *most frequent* etiologic factor in the production of an aneurysm. However, it is not generally recognized that the trauma incurred in the performance of a surgical procedure or operation is an additional factor in the production of these lesions. Operative procedures have become so commonplace that safety factors which prevent serious complications are occasionally overlooked. The purpose of this report is to call attention to the possibility of arterial injury accidentally produced in the course of an operation, eventuating in an aneurysm or a fistula.

Accounts of injuries to blood vessels have been recorded since the beginning of medical history, and among the writings of Galen in the first century of the Christian Era we find descriptions of aneurysms produced accidentally in the course of bloodletting.† Although bloodletting has long passed into

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† "One of the earliest and most interesting references in literature is to an instance of this kind. Galen was called in consultation by a young and inexperienced surgeon who had opened the artery at the bend of the elbow instead of the vein, and the blood spurted out 'clarus, rubens, lucidus et caid'. (*See footnote continued on next page.*)

Delays in the appearance of this and other recent issues of the ANNALS OF SURGERY have been due to present unsettled conditions in the printing trades. A return to original schedules is expected as soon as a settlement of these difficulties is reached.

oblivion, the re-introduction on a large scale of both venous and arterial puncture as a diagnostic and therapeutic measure will probably be followed by an increased number of aneurysms and fistulas.

The early medical history of blood vessel injury, although primarily concerned with the arrest of hemorrhage and the use of ligatures, makes frequent mention of aneurysms. It was not until 1757, however, that William Hunter accurately described an arteriovenous shunt and its effect upon the local circulation. Hunter's two cases were both produced accidentally by bloodletting, it being supposed that the lancet puncturing the basilic vein pierced too deeply and injured the underlying radial or brachial artery at the same time.*

A survey of the literature reveals numerous reports of arteriovenous fistulas following surgical procedures. This lesion has been produced between the inferior vena cava and the right iliac artery during operation for ruptured intervertebral disk;[1] it has been seen in amputation stumps,[2] and in the uterine vessels following hysterectomy.[3] Instances have been reported of intercostal arteriovenous fistula following thoracentesis,[4] of the facial vessels, caused by application of a Roger Anderson splint,[5] of the anterior tibial vessels following introduction of a Steinmann pin,[6] and of the superior thyroid artery following thyroidectomy.[7] I have seen it in the posterior tibial vessels following introduction of a Steinmann pin, and in the genicular vessels following an operation for the removal of a semilunar cartilage; but as these two patients refused operation, they are not included in this report.

It is thus evident that an arteriovenous communication may be produced in any operation. It is most likely that the lesion is produced when vessels are transfixed and ligated, an artery and vein being injured simultaneously by the needle, and an opening made through which the communication is subsequently established. Although transfixion and ligation of a vessel are standard procedures, it should be remembered that mass ligation of arteries and veins may well give rise to this lesion (see Case 5). Particular care should be taken to avoid the inclusion of more than one vessel in a transfixion suture. In addition,

* Hunter's first case was published in *Medical Observations and Inquiries by a Society of Physicians in London,* in 1757 (Volume 1, page 323). His second case was reported in the same journal in 1762 (Volume 2, page 390). The exact time of his observation of these patients is unknown but is supposed to have occurred several years before the publication of the reports.

(*Footnote continued from p.* 769) 'I took in the situation at once; there happened to be an elderly physician with me, so we prepared a medicine, viscid, conglutmable, and obstructive, and placing it strongly against the lips of the wound bound over it a soft sponge. The surgeon who had opened the artery wondered, but said nothing. When we went out [note the professional touch!] I said to the surgeon that he had opened the pulsating vessel, and charged him not to dress the wound before the fourth day, and not without me.'

"The cure was complete, and Galen remarks that this was his only successful case of the kind, as in all others aneurysm had followed." Sir William Osler, Remarks on Arterio-Venous Aneurysm. Lancet, Lond., 1, 949, 1915.

traction pins, wires, and fixation devices for immobilization of bones should not be inserted near the known anatomic course of blood vessels.

In a personal series of approximately 650 operations for aneurysm and arteriovenous fistula, six definitely followed operation or some surgical procedure, and it may be presumed, therefore, that approximately one per cent of these lesions follows operative trauma. One of these cases has been previously reported,[3] and this communication is concerned primarily with five additional instances of this lesion.

Case 1—*S.H., Hosp. No. 10123, soldier, age 30: False aneurysm, right brachial artery, lower third, following diagnostic venepuncture August 1944. Treatment by Matas endo-aneurysmorrhaphy, September 19, 1944. Recovery.*

This 30-year-old soldier was transferred to the Army vascular center at Ashford General Hospital with a diagnosis of mycotic aneurysum of the right brachial artery. The patient had had bacterial endocarditis, and at the time of his transfer had mitral stenosis. The aneurysm had developed at least six week after his blood cultures were negative. Shortly before the aneurysm developed, blood was drawn from the patient's arm in this region on numerous occasions. He complained of swelling of the right forearm of seventeen days duration, numbness of the first and second fingers, congestion of the hand on dependency, excessive sweating and loss of complete motion of the elbow.

Examination revealed a fusiform swelling of the upper right forearm on the anterior aspect. It was approximately 8 cm. in diameter, and over it a faint thrill could be felt. The mass pulsated, and on auscultation a systolic bruit, not transmitted to the hand or the axilla, could be heard over it. There was congestion of the right hand and cyanosis of the nail beds on both sides. Both hands were mildly sweaty. Oscillometric readings at the wrists were normal, slightly higher on the left than on the right. Skin temperatures were excessively high on both sides. The Kahn test was negative. A diagnosis of false, traumatic aneurysm of the right brachial artery was made.

Endo-aneurysmorrhaphy (Matas) was performed September 19, 1944 under nitrous oxide, oxygen and pentothal sodium. Under a tourniquet, an incision was made just over the aneurysmal swelling, beginning at the crease of the elbow and extending down about 10 cm. The aneurysm was found to ramify deep in the muscles and between the ulna and radius. It was opened and a large clot evacuated. The appearance of the sac was that of a false aneurysm as seen following trauma. The lining was smooth; there was no evidence of infection, or of vegetations. An upper and lower opening in the wall of the artery could easily be seen, and these were closed with interrupted sutures of silk. After closure of the wound, an ace bandage was applied from the wrist to the midarm. The hand was warm, and there was good return of circulation after pressure on the fingers. The postoperative course was uneventful.

Case 2—*Mrs. M.P., E.U. 1178, age 57: False aneurysm, left brachial artery, lower third, produced by incision of abscess forty years previously. Treatment by excision, April 9, 1947. Recovery.*

This patient had an abscess of the left arm and forearm when she was 18 years old, which was incised and drained. During a period of hospitalization in 1938, it was noticed that she had a mass in the left forearm near the elbow. The condition was entirely asymptomatic until the summer of 1946 when her left arm became weak and stiff after a period of carrying groceries. During the succeeding few months she had pain in her left arm, extending into the left shoulder region. This became more severe, and in January 1947 she noticed swelling of the left hand with occasional numbness and tingling.

Examination revealed an old operative incision on the anteromedial aspect of the left arm near the elbow, and a larger incision on the anterior surface of the arm at a slightly higher level. A firm, expansile mass was present, extending from just above the

antecubital fossa for a short distance inferiorly. A bruit, present only in systole, was heard over the mass. On palpation of the incision a defect in the underlying muscle and fascia was noted, and the pulsation of the brachial artery was readily detected. Slight pressure in this region obliterated the expansile pulsation. Oscillometric readings and skin surface temperatures were normal. There was no color change of the extremities on positional changes. Radial and brachial pulsations were normal. The Kahn test was negative. A diagnosis of arterial aneurysm, left brachial artery, lower third, was made (Fig. 1).

FIG. 1

FIG. 2

FIG. 1.—Case 2: Preoperative photograph. False aneurysm of the brachial artery following incision of abscess.

FIG. 2.—Case 2: Postoperative photograph showing incision curved transversely across the antecubital fossa.

On April 8, 1947, excision of the aneurysm was performed under pentothal sodium, nitrous oxide and ether. A pneumatic tourniquet was applied to the upper arm. An incision was made longitudinally over the mass for about two inches and curved transversely across the elbow in line with the skin fold (Fig. 2). A large number of superficial veins were divided and ligated. The mass was oblong, about 2 by 4 cm.; its capsule was tough and could easily be dissected from surrounding structures. The proximal and distal arteries were ligated and divided, and the mass completely enucleated. The vessels were soft and showed no evidence of arteriosclerosis. The aneurysm was

FIG. 3.—Case 3: Preoperative photograph. False aneurysm of the external iliac artery following repair of hernia.

FIG. 4.—Case 3: Postoperative photograph showing incisions.

lying directly on the median nerve, but this structure was not disturbed. After the wound was closed, an elastic bandage was applied from the finger tips to the midarm. There was no pulsation of the radial artery at the wrist following operation, but the hand was warm and the circulation in the fingers good. Recovery was uneventful. Examination of the specimen showed a typical false aneurysm with a smooth-walled, fibrous sac.

Case 3—*C.M., E.U. 1166-936, male, age 38: False aneurysm, left external iliac artery, following herniorrhaphy performed May 1946. Treatment by Matas endoaneurysmorrhaphy, January 23, 1947. Recovery.*

This man had a left inguinal hernia repaired on May 13, 1946. He was told after the operation that a blood vessel had been injured. His surgeon stated that he "encountered some bleeding when a stitch was placed to unite the conjoined tendon to the inguinal ligament, but the bleeding was easily controlled by a ligature". Two months following operation, the patient noticed in the left inguinal region a small, firm mass which gradually increased in size over a period of about four months, and then suddenly enlarged causing severe pain in this region. Two months prior to admission to the hospital in January 1947, a smaller mass developed at the inferior limit of the first one. There was no further progression in the size of either. The patient complained of pain in the left inguinal region on exercise. There was no weakness, claudication, or swelling of the extremity.

Examination revealed a lobulated, pulsating mass, approximately 12 cm. in diameter, under a left inguinal incision (Fig. 3). At the inferior limit of this mass was a smaller mass measuring 2.5 cm. in diameter. A systolic bruit with a slight pause and a diastolic murmur were audible. The murmur was not continuous, nor was it transmitted beyond the confines of the mass. The veins of the extremities were not enlarged. The lower extremities were equal in size and without abnormal color changes, ulceration or pigmentation. There were no color changes on positional maneuver. There was moderate sweating of both feet. Skin surface temperatures of the toes of both feet were moderately reduced but equal bilaterally. The right dorsalis pedis pulsation was faint; the left was absent. Oscillometric readings were bilaterally equal, symmetrical and normal. The Kahn test was negative. A diagnosis of arterial aneurysm of the left external iliac artery was made.

On January 23, 1947, under continuous spinal anesthesia, a sympathectomy was performed prior to the operative repair. A low abdominal incision was made, the peritoneum was reflected medially without opening it, and the common iliac artery was exposed. The lumbar sympathetic chain was exposed and the third ganglion removed. A clamp was placed on the common iliac artery temporarily to occlude it.

A longitudinal incision was then made directly over the aneurysm which pointed under Poupart's ligament (Fig. 4). The sac was opened and a large clot removed. Bleeding was brisk but the opening was found and could be controlled by occlusion with a finger. The opening itself was closed with four interrupted sutures of silk. There was considerable oozing from the wound which probably indicated a good collateral circulation. At the end of operation, the patient's foot was warm and pink, and the color returned rapidly after pressure. Recovery was uneventful.

Case 4—*Mrs. E.B., GR.A132223, age 44: Arteriovenous fistula, right facial vessels, following injection of procaine thirty years previously. Treatment by quadruple ligation and excision of fistula, October 15, 1946. Recovery.*

This patient reported September 27, 1946 because of a tumor on the right side of her jaw. Her dentist had refused to pull a tooth until the tumor was removed, for fear of hemorrhage. The patient gave a history of having had a right lower molar extracted when she was twelve years old. Procaine was injected prior to extraction of the tooth. The tumor, which was about the size of an acorn and of bluish color, was first noticed when the swelling following extraction subsided. Since that time it had slowly grown to about 3 cm. in diameter.

Examination revealed a bluish streak, 3 cm. wide, extending from the right corner of the mouth down across the angle of the jaw and terminating over the bifurcation of the cartoid artery. Slightly above the streak where the facial artery crossed the mandible, there was a soft, nontender mass about 3 by 4 cm. in diameter. This could be collapsed on pressure, but refilled rapidly. There was continuous thrill and bruit, accentuated in systole, over the entire mass. The pulse rate was 88, and the heart sounds were of good

quality with no irregularities or murmurs. A diagnosis was made of arteriovenous fistula, right facial artery and vein at angle of the mandible (Fig. 5).

On October 15, 1946, under intratracheal nitrous oxide, oxygen and ether anesthesia, operation was performed. A linear incision about 5 cm. long was made transversely below the lower border of the mandible on the right side, beginning just anterior to the angle and extending forward. As it was impossible to isolate the main proximal and distal vessels to the fistula, the mass was enucleated. The proximal and distal arteries and veins, together with the collateral vessels, were ligated and divided. The wound was closed and a pressure dressing applied. Recovery was uneventful (Fig. 6).

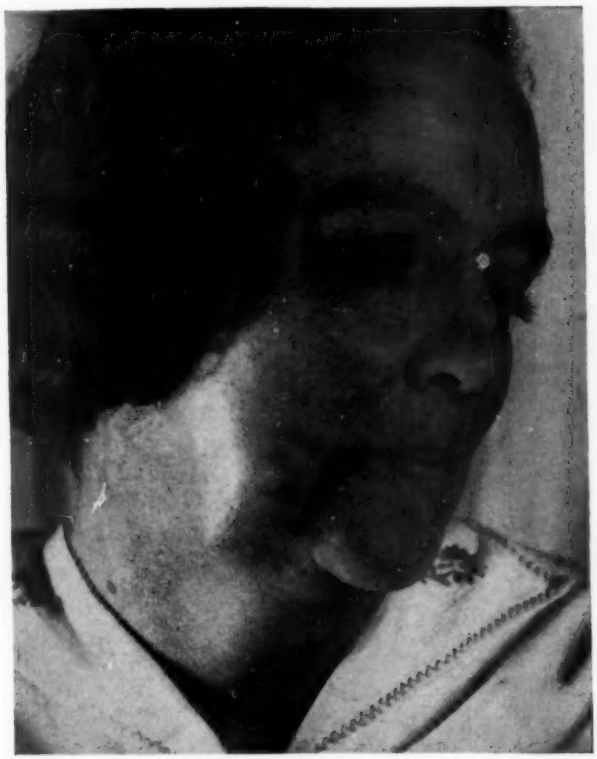

FIG. 5.—Case 4: Preoperative photograph. Arteriovenous aneurysm of the facial vessels following procaine injection.

Case 5—*S.V., E.U. 167-273, male, age 50: Arteriovenous aneurysm, right renal vessels, following nephrectomy for tuberculosis in 1926. Treatment by ligation of right renal artery, February 11, 1947. Recovery.*

A printer, age 50, had had his right kidney removed in 1926 because of tuberculosis. His surgeon stated later that the operation was performed in a routine manner and that no unusual difficulty was encountered. He further stated that it was possible that the artery and vein had been ligated en masse. His recovery was uneventful, and he left the hospital on the sixteenth postoperative day. For ten years he had suffered from shortness of breath, and in 1943 he began to have a feeling of oppression and constriction in his chest, which awakened him at night. This was diagnosed as pericarditis, and he was placed in a hospital for a week. His tolerance for activity decreased, and he became so short of breath that he had to sit up in bed to sleep comfortably. He

complained of increasing weakness, nervousness, and periodic headaches. In December 1945 he again was in the hospital for three days because of a friction rub over the left lower lobe of the lung which was treated with penicillin. He had recurrent bouts of pleuritic pain, and over a three-year-period on occasion coughed up bright red blood. In 1946 he became conscious of a thumping sensation in his arms and neck when he sat on a hard chair. During a physical examination in December 1946, his physician (Dr Mason I. Lowance) noted a loud, rough murmur over the region of the flank wound. At this time moderate cardiac enlargement was noted.

He was admitted to the hospital January 29, 1947. Examination revealed a healed right flank wound over which a loud continuous bruit, accentuated on heart beat, could

FIG. 6.—Case 4: Postoperative photograph after excision of arteriovenous aneurysm.

be heard. The heart showed marked left ventricular enlargement; the sounds were loud, and a systolic murmur was heard at the apex. There was an increase in blood volume of approximately 450 cc. above the normal level. A diagnosis of arteriovenous aneurysm of the right renal vessels was made.

Operation was performed February 11, 1947 under nitrous oxide and ether anesthesia. A transverse incision was made, beginning at the costal border on the right, and carried directly across the abdomen, dividing both recti muscles (Fig. 7). The peritoneum was opened without difficulty. The liver was considerably enlarged. Just to the left of the vena cava, a distinct thrill could be felt. This region was exposed by opening the peritoneum along the right lateral border of the duodenum and reflecting the duodenum to the left, completely exposing the vena cava and the right kidney fossa (Fig. 8). The vena cava was greatly enlarged, perhaps three or four times its normal size, and was

covered with a network of greatly dilated veins thought to be the venae comites. Just to the right of the vena cava there was a soft knob-shaped protrusion, evidently the end of the renal vessels. This was the point of maximum thrill. The thrill could be obliterated by pressure on this point, and the opening between the artery and vein, about the size of the tip of the finger, could be felt. It was believed that the shunt of the blood from the stump of the renal artery into the stump of the renal vein was the cause of the great enlargement of the vena cava and of the dilated venae comites. An effort was made to dissect the stump of the renal artery free from the stump of the renal vein, but this was discontinued since it was evident that the accidental opening of the vein might lead to rapid and fatal hemorrhage. Therefore, the vena cava was separated from the aorta and the right renal artery was isolated as it passed behind the vena cava. This artery

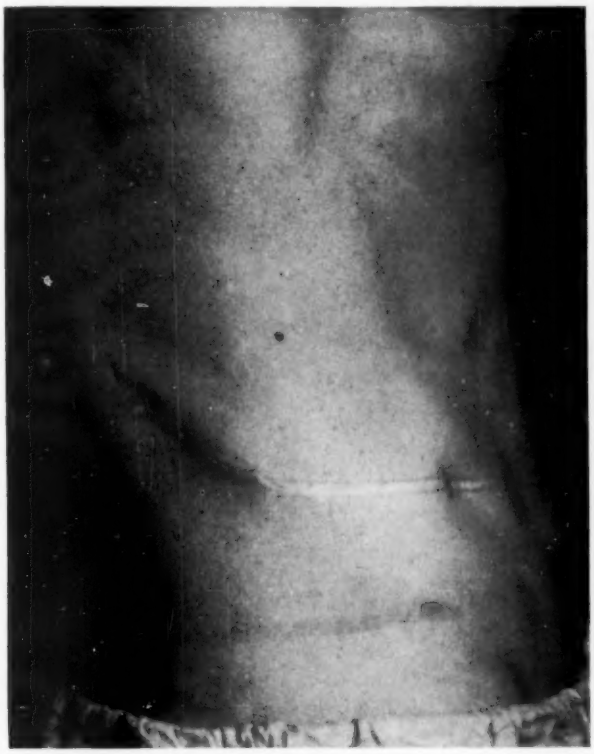

FIG. 7.—Case 5: Postoperative photograph showing transverse incision.

was enlarged to about twice its normal size. It was doubly ligated with medium braided silk, the ligatures being placed about 1 cm. apart. The thrill immediately disappeared, and it was believed that this would cure the condition since there are no branches of the renal artery.

Observations were made during the course of the procedure. The blood pressure, which before operation was usually 180/70, fluctuated considerably, perhaps due to interference with the splanchnic nerves in this region. On compression of the fistula, there was a drop in pulse of twelve beats per minute, and the diastolic pressure rose to 100 mm. of mercury and remained at that level. He withstood the operation well, and his recovery was uneventful.

He has been examined on several occasions since the operation, but the enlargement of his heart has persisted and the symptoms of cardiac failure, as evidenced by dyspnea, have remained. It is believed that his cardiac failure resulted from the presence of this large arteriovenous shunt over a period of 21 years, so affecting his heart as to produce irreversible damage. There has been no return of the bruit.

SUMMARY

In a series of approximately 650 operations for aneurysm and arteriovenous fistula, six have been encountered which were believed to be the direct result of accidental injury of a blood vessel during the course of an operative procedure. One of these was previously reported.

The history of five additional cases is reviewed with description of the location of the lesion, type of injury, and the treatment.

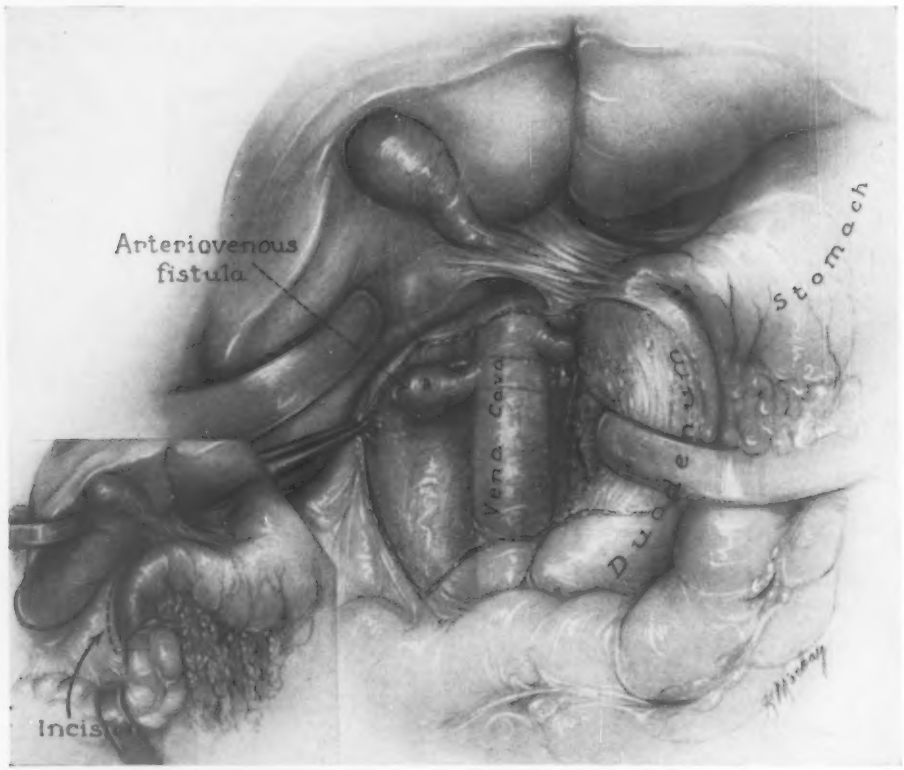

FIG. 8.—Case 5: Arteriovenous fistula in stump of renal vessels. Treatment by double ligation of the renal artery. Insert shows line of incision for mobilization of duodenum and exposure of renal fossa.

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ANEURYSM OF THE LEFT COMMON ILIAC ARTERY SECONDARY TO A TRAUMATIC ARTERIOVENOUS FISTULA OF THE LEFT POPLITEAL VESSELS*

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There have been numerous reports of tremendous dilatation of an artery proximal to an arteriovenous fistula. Likewise there have been a few reports of an aneurysm developing in an artery proximal to an arteriovenous fistula. Since this latter complication with respect to an arteriovenous fistula is infrequent, an additional case with reference to several interesting features is submitted.

CASE REPORT

R. G. A colored male, age 61, first came under my observation on April 9, 1946, complaining of weakness and nervousness.

Past history.—At the age of 18 (43 years ago) he was shot through the left leg with a .38 caliber pistol. The bullet entered the leg posteriorly at the lower level of the knee and made its exit anteriorly just below the patella. Since that time he has complained of a pulsating mass in the left popliteal space and swelling of the left lower extremity. Large varicose veins have been present in the involved extremity for the past 35 years, extending up to the left groin. A varicose vein of the left leg ruptured 25 years ago following exertion and caused a severe hemorrhage. A hematoma developed and was incised and drained, requiring 8 months' bed rest before the resulting ulcer healed. A large pigmented area on the anterior surface of the leg has been present since that time. The patient has worn a supporting bandage on the left leg for the past 25 years. He has continued to complain of impaired circulation in the left leg. In recent years he has developed mild dyspnea on exertion and palpitation of the heart. Epigastric discomfort has been present for the past 6 months.

He gave no history of syphilis and stated that repeated "blood tests" have been negative. One year ago he first noticed a pulsating mass in the left lower abdominal quadrant, which has grown progressively larger but has caused him no apparent discomfort. No history of frank left or right sided heart failure was obtained. His weight has decreased from 203 to 161 pounds in the last year.

Physical examination.—The patient showed evidence of moderate weight loss. Blood pressure was 140/70. The pulse rate was 76. There were frequent premature beats. The heart was enlarged 3 cm. beyond the normal limits. Aortic and mitral systolic murmurs were present.

Abdominal examination revealed a large expansile, pulsating mass in the left lower quadrant corresponding with the location of the left common iliac artery. The mass was approximately the size of a grapefruit, measuring 10 cm. x 12 cm. On auscultation a loud systolic bruit could be heard over the mass.

The left lower extremity was considerably larger than the right. Large varicosities were present from above Poupart's ligament down to the ankle. The leg showed edema and induration of the soft tissues with extensive pigmentation and scarring from previous ulcerations.

Examination of the popliteal space revealed a large pulsating mass measuring approximately 8 cm. x 12 cm. and filling the entire space. A thrill could be felt over the mass. On auscultation a loud continuous bruit could be heard with greatest intensity

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over the popliteal space but extending well onto the thigh and the leg. By palpation the femoral artery was found to be dilated.

Obliteration of the arteriovenous fistula by digital pressure produced a slowing of the pulse rate from 72 to 56 per minute (positive Branham's sign) and an elevation of blood pressure reading from 120/50 to 170/90. There was no clinical evidence of diminished circulation in the involved leg or foot following obliteration of the fistula.

Hemoglobin was 78%, erythrocyte count 3,980,000 and the leucocyte count 5,100. Urinalysis was negative. The blood Wassermann was negative. Roentgen-ray examination of the chest revealed definite cardiac enlargement. Electrocardiographic interpretation May 6, 1946, by Dr. John B. Burrett, revealed a borderline tracing compatible with myocardial damage. It showed auricular bigeminy; auriculoventricular and intraventricular conduction duration at upper limit of normal (0.2 and 0.10 - 0.11 seconds respec-

A B

FIG. 1.—A. Anterior view before operation showing enlargement of the left lower extremity, varicosities and extensive pigmentation of the leg. B. Lateral view of the left leg showing prominence of the popliteal space at the site of arteriovenous fistula.

tively); prominent Q in C F 4, 5 and 6. Subsequent electrocardiograms (following operation) have shown no significant change from that described above except that in one taken recently premature beats were no longer present.

Diagnosis.—(1) Arteriovenous fistula of the left popliteal vessels of 43 years' duration. (2) Large fusiform aneurysm of the left common iliac artery secondary to the popliteal arteriovenous fistula.

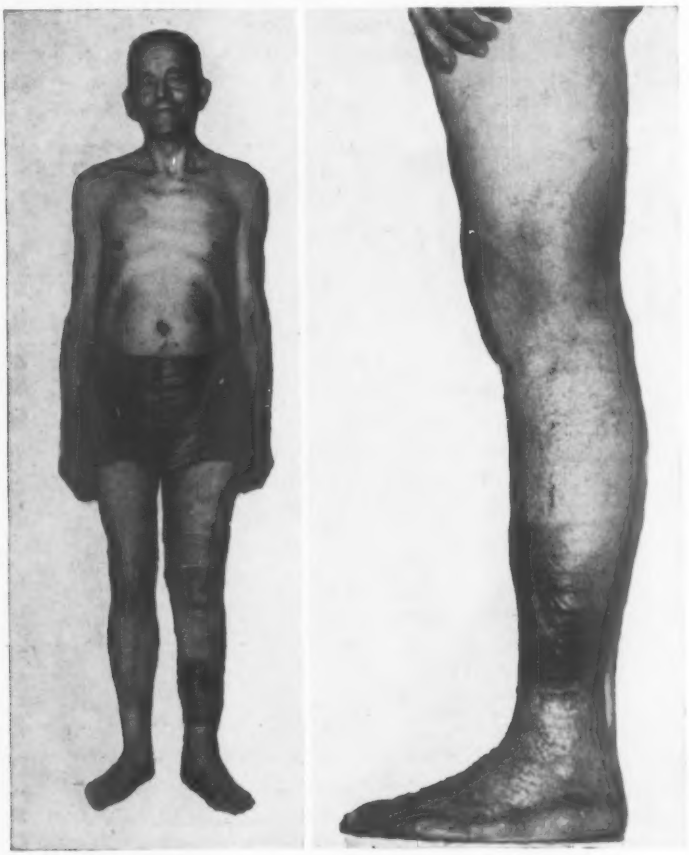
After consultation with Drs. J. M. Mason and D. C. Elkin, it was considered advisable to operate on the arteriovenous fistula with the hope of improving the status of the iliac aneurysm, the heart and the circulation in general.

The patient was admitted to South Highlands Infirmary on May 29, 1946. The Matas

test proved the circulation to be adequate when the fistula was obliterated. The patient was instructed to obliterate the fistula at frequent intervals in order to accommodate the cardiovascular system to the changes incident to elimination of the fistula.

Operation June 3, 1946. Sextuple ligation (popliteal artery and vein proximally and anterior and posterior tibial arteries and veins distally) and complete excision of the arteriovenous fistula.

Under spinal (pontocaine) anesthesia, a tourniquet was applied to the upper thigh.



A *B*

FIG. 2.—A and B. Anterior and lateral views made 18 months after operation showing a decrease in the size of the left lower extremity and less evidence of varicosities.

The patient was placed in the prone position and an incision 20 cm. in length was made over the popliteal space. The common peroneal and tibial nerves were dissected free of the aneurysm and were retraced laterally. A large saccular arteriovenous aneurysm was found filling the popliteal space. It measured 8 cm. in width and 12 cm. in length. The popliteal vein was 5 cm. in diameter. The popliteal artery was thinner than normal and was densely adherent to the vein. The artery proximal to the fistula was dilated to 1.5 cm. in diameter and thin walled. The fistula was present just at the level of bifurcation of the popliteal artery. The anterior and posterior tibial arteries were found to be larger than normal. It was impossible for me to separate the artery and vein at the site of the fistula. After ligating the popliteal artery and vein proximally and the anterior and

FIG. 3 — Posterior view after operation showing the relative size of the two extremities and the line of incision.

posterior tibial arteries and veins distally with heavy silk, the intervening segment, including the fistula, was excised. A penrose drain was inserted and the wound was closed, obliterating the dead space as much as possible.

At the end of the operation the blood pressure reading was 150/110. The pulse rate was 90 and the rhythm was regular, whereas before the operation many extra systoles were present. The left foot and leg were as warm as the right. The pulsations and bruit in the iliac aneurysm were definitely diminished in intensity. No pulsation could be felt in the left posterior tibial or dorsalis pedis arteries either before or after operation.

The specimen measured 13 cm. x 6 cm. In the middle there was a fusiform enlarged portion measuring 6 cm. x 4 cm.; which proved to be the popliteal vein. The vein wall was tough and irregularly calcified. Several saccular swellings arose from the popliteal vein opposite the fistula. There was considerable fibrosis of the walls of the artery but this was more marked in the vein. The fistula was located at the level of the bifurcation of the popliteal artery and apparently involved its anterior and posterior tibial branches at the site of the communication with the popliteal vein. The fistula was approximately 1 cm. in diameter.

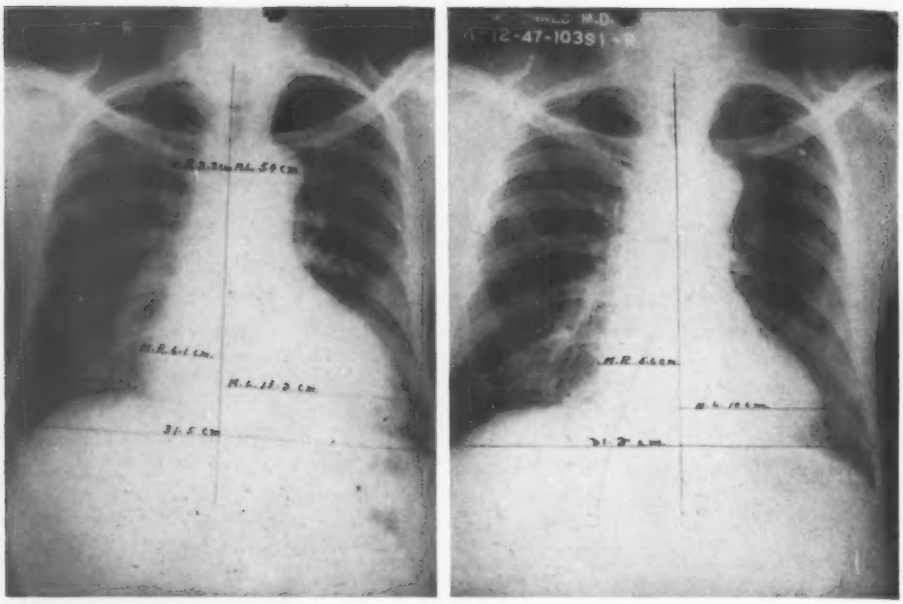
Postoperative course.—The patient developed a low grade infection in a hematoma of the wound. The penrose drain may have been a factor in this complication. There was an associated mild cellulitis of the thigh just above the wound. The wound continued to drain until all silk sutures were recovered. The circulation has remained good in the left foot and leg following operation. There has been a progressive decrease in the size of the iliac aneurysm. Six foot chest roentgenograms show definite decrease in heart size following operation.

The last examination on November 12, 1947 (18 months after expiration of the arteriovenous fistula) revealed the iliac aneurysm to be reduced to 1/3 its original size. The bruit over the aneurysm is very faint. The left femoreal artery remains somewhat dilated but has diminished in size. There is no clinical evidence of heart disease. The circulation distal to the site of the arteriovenous fistula is better than before operation. The patient has gained 50 pounds and is working regularly. The left thigh, though smaller than before operation, remains larger than the right and the patient has continued to wear a bandage on the left leg to control oedema. Blood pressure was 140/90. The pulse rate was 76 and was regular in rhythm.

COMMENT

In an admittedly incomplete review of the literature there have been nine cases of this particular complication reported.[1-9] It is only in arteriovenous fistulae of many years duration (13 to 40 years in this series) that these proximal arterial aneurysms have been observed.

William Hunter[10] in 1762 was the first to accurately describe an arteriovenous fistula. Since that time outstanding contributions by Matas, Reid, Callander, Holman, Mason, Pemberton, Bigger, Gage, Elkin and others have emphasized the serious systemic or cardiovascular effects of an arteriovenous fistula and have developed adequate methods of treatment. This discussion



A B

FIG. 4.—A. Roentgenogram of the thorax made before operation showing enlargement of the heart. B. Roentgenogram made after operation which reveals definite decrease in the size of the heart. This decrease in size occurred within a few weeks following operation and has remained this size.

will be limited chiefly to the effects of an arteriovenous fistula on the proximal artery and more specifically to aneurysm of the proximal artery.

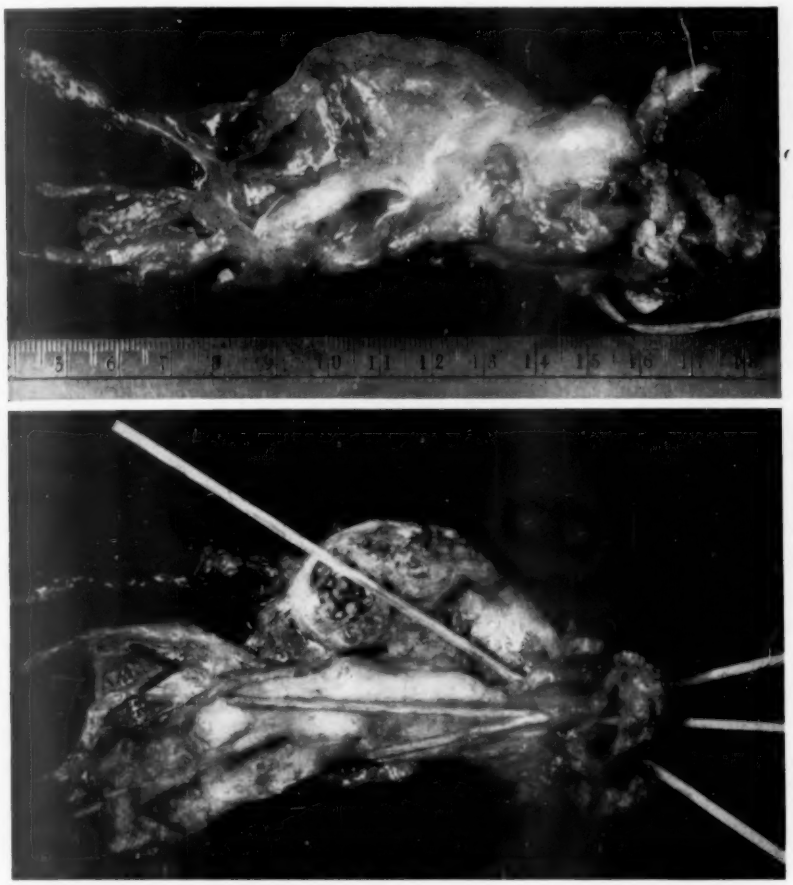
In the article referred to above, Hunter likewise called attention to dilatation of the artery proximal to an arteriovenous fistula. In describing this finding in a case of arteriovenous fistula of the brachial vessels he stated "A little above the bend of the arm the artery makes a remarkable serpentine turn which raised up the skin and by force of the pulsation looks as if it was a beginning aneurysm. The artery at the wrist is much smaller and its pulsations much weaker than that of the opposite side."

Callander[11] in 1920 analyzed 447 cases of arteriovenous fistula and found a record of proximal dilatation of the artery in 57 cases (12.7%). The artery distal to the fistula was usually contracted. In only 3 instances in this large series was the distal artery found to be dilated. Reid[14] observed dilatation of the distal artery in one of his cases. The distal arteries in the present case were larger than normal.

Matas[12] found notable enlargement of the artery proximal to the fistula in the majority of his long standing cases. In several instances the thoracic aorta participated in the arterial enlargement. Matas[13] further stated that the enlargement of the artery on the proximal side of an arteriovenous fistula and increase volume of blood that flows through it is but an effort to compensate

for the relative ischemia of the tissues below the fistula and that the enlargement of the artery is directly proportional to (a) the size of the fistula (b) the volume of arterial blood that is short circuited into the veins at the fistula and (c) the duration of the fistula.

A



B

FIG. 5.—Excised segment of popliteal artery and vein containing fistula. A. Unopened specimen showing fusion of artery and vein and sacculation of the popliteal vein. B. Specimen opened to demonstrate fistulous communication between artery and vein. Note extensive calcification in the popliteal vein.

Reid[14] observed that a fistula between an artery and vein leads to definite changes in the vessels. The arteries proximal to the fistula become dilated and thin walled and often show marked degenerative changes. The veins dilate and their walls may become thickened. He suggested that the alterations in pulse pressure might be responsible for the atrophy of the artery and hyper-

trophy of the vein. He further suggested that some alternation in the nutrition of the vessel walls might be a factor in these changes.

Holman[15] explained the cardiac enlargement and the dilatation of the proximal vessels associated with an arteriovenous fistula on purely mechanical

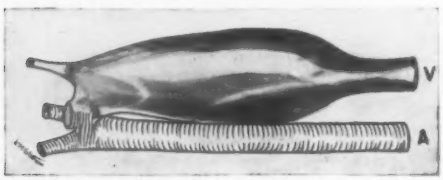


Fig. 6.—Drawing to demonstrate site of fistula at the bifurcation of the popliteal artery. The dilated fusiform vessel represents the popliteal vein.

and physical grounds. The area of lowered resistance produced by the fistula results in the establishment of two routes for the passage of blood (1) through the normal capillary bed back to the heart, (2) through the fistula back to the heart. A greater volume of blood will be directed toward the fistula than toward the capillary bed and this greater flow of blood produces the dilatation of the vessels leading to and from the fistula.

Just as the vessels respond to the greater volume of blood passing through them, so will the heart dilate to accommodate the increased flow through its chambers. The amount of blood short circuited will depend upon the size of the fistula and upon the unobstructed return flow to the heart. Holman reports a case of a large arteriovenous fistula of the femoral vessels of 26 years' duration with marked dilatation of the heart and proximal vessels in which there was almost complete disappearance of the dilatation following quadruple ligation and excision of the fistula. He believed that circulatory changes are dependent primarily upon the size of the fistula and upon an unobstructed return flow to the heart, and that the duration of the fistula is a factor of minor importance. Holman[16] further explained the physiologic effects of an arterio-

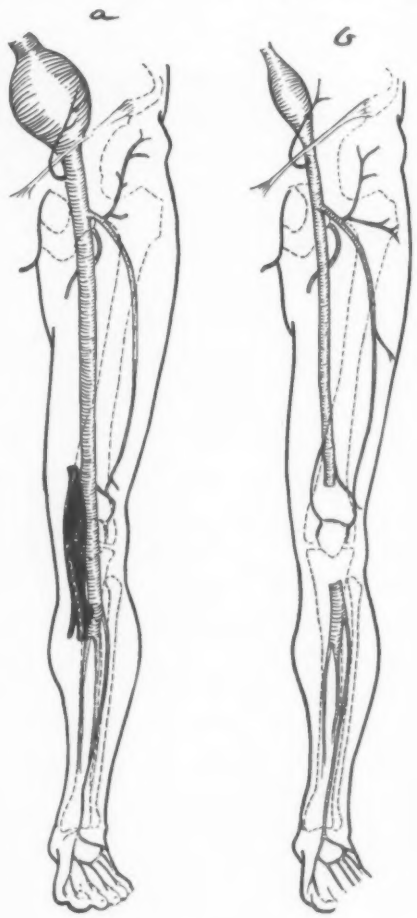


FIG. 7.—A. Drawing to illustrate the size of the iliac aneurysm and the femoral artery proximal to the arteriovenous fistula. A segment of the popliteal vein at the site of the fistula is included in the drawing.

B. Drawing to illustrate the reduction in size of the iliac aneurysm and the femoral artery following extirpation of the fitula.

venous fistula by considering the short circuit to the heart as a new circulation parasitic upon the normal circulation.

Pemberton[17] in a discussion of the degenerative changes in the artery proximal to an arteriovenous fistula called attention to the increased intra-arterial pressure and weakened arterial wall as rendering conditions ideal for the production of an aneurysm and warns that this danger must be thought of as a potential complication in all neglected cases of arteriovenous aneurysm.

Elkin[9] has pointed out that the improvement of an aneurysmal dilatation in the proximal artery after elimination of the arteriovenous fistula will depend upon the amount of damage which has already taken place in the artery and that this damage may be irreversible.

Reid[6] and Neuhof[8] each reported a case in which an aneurysm developed in the proximal artery several years after the arteriovenous fistula had been eliminated. In Reid's patient the fistula of the femoral vessels in Hunter's Canal had been present for over 30 years. The artery was dilated from the fistula back to the heart. At operation Dr. Halsted separated the artery and vein at the fistula and then reestablished continuity of both vessels. Six years later a large true aneurysm developed in Scarpa's triangle. In the case reported by Neuhof a large dissecting aneurysm of the left iliac artery developed nine years after quadruple ligation and excision of an arteriovenous fistula of the left femoral vessels by Dr. Pemberton. This arteriovenous fistula had been present for 31 years.

In the case herein reported the popliteal arteriovenous fistula had been present for 42 years before the iliac aneurysm made its subjective appearance. Although the size of the fistula was relatively small (approximately 1 cm. in diameter) the patient had exhibited all the local signs of an arteriovenous fistula (varicosities, trophic ulcers and deficient circulation of the leg) for many years before obvious systemic effects became manifest (enlargement of the heart, incipient cardiac decompensation, dilatation of the proximal artery and aneurysmal dilatation of the iliac artery). The iliac aneurysm in this patient is considered to be a direct result of the arteriovenous fistula for the following reasons: (a) It developed in the artery proximal to the fistula. (b) There has been no history of a syphilitic infection. (c) There was marked diminution in size of the aneurysm following extirpation of the arteriovenous fistula.

This case tends to confirm the observation of Matas[13] that the duration of an arteriovenous fistula, as well as the size, is an important factor in the production of dilatation of an artery proximal to an arteriovenous fistula.

SUMMARY

A case of traumatic arteriovenous fistula of the popliteal vessels of 43 years duration is reported. A large, true aneurysm of the iliac artery proximal to the fistula developed several years after the onset of the fistula. The femoral artery was dilated from the fistula to the aneurysm. The heart was enlarged and there was evidence of myocardial damage.

Following sextuple ligation (popliteal artery and vein proximal to the fistula and the anterior and posterior tibial arteries and veins distally) and excision of the fistula, there was prompt reduction in the size of the iliac aneurysm. Six months after operation the aneurysm had reduced to ⅓ its original size and the systolic bruit was only faintly audible. The heart has definitely decreased in size as demonstrated by roentgen-ray. There has been no evidence of cardiac decompensation and the circulation in the involved leg has shown decided improvement. Examination 18 months after operation revealed no significant changes in the findings noted above.

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DISCUSSION.—DR. EDWARD F. PARKER, Charleston, S. C.: We wish to congratulate the speakers, and Doctor Blakemore * in particular on his most ingenious and brilliant method of dealing with such a difficult lesion as aneurysm of the aorta.

Recently we were faced with the problem of having to deal with a large luetic saccular aneurysm of the mid-descending portion of the thoracic aorta. The wall of the

* Dr. Blakemore's paper "Surgical Aspects of Aneurysm of the Aorta" will appear in the Southern Surgical Transactions, Vol. 59, 1947.

aneurysm was already badly torn, and a fatal hemorrhage was imminent. We did not have the equipment described by Doctor Blakemore, and therefore decided to try complete double ligation of the aorta in stages, with the ultimate goal that of complete excision of the aneurysm and the intervening segment of aorta involved. Though we did not meet with success, we feel that it is of interest to report the case.

The patient was a 38-year-old Negro. He looked perfectly healthy, but had been spitting up blood four or five times a day for the previous eight months. In the week before admission to the hospital he had had two very massive hemoptyses; during the second, he said that he spit up at least a quart of blood. X-rays of the chest (slides) showed a large rounded mass in the region of the hilum of the left lower lobe. On fluoroscopy, the mass did not appear to pulsate and, in particular, no expansile pulsation could be noted. Other studies which were done shed no light. We did not know what it was, thought it likely that it was carcinoma, and did an exploratory thoracotomy on the 5th of November of this year.

As soon as the left chest was opened it was apparent that the mass was an aneurysm of the aorta as it had an expansile pulsation which could be felt through the overlying adherent lung. The lung was freed from it with difficulty, as it had eroded the lung (slide). In doing this, the wall of the aneurysm was torn (slide) so that the lamellated clot was exposed. Why the aneurysm did not bleed at that moment we will never know, but it did not. Therefore, we decided to do a proximal ligation of the aorta, and occluded the aorta just above the aneurysm, about 70 per cent. This was done with two ox fascia ligatures tied over a tape of cellophane (slide).

Following operation, tests for renal function were normal. The patient complained of coldness of the feet for several days, but then subjective warmth returned. Even so, his feet remained rather ischemic although both dorsalis pedis pulses were present but weak immediately following operation. A mild hypertension persisted only a few days. On the 13th postoperative day he died of rupture into the left pleural cavity after the induction of anesthesia for a second-stage distal partial ligation, but before the operation could be carried out.

Autopsy showed grossly normal kidneys, liver and heart. The ligatures on the aorta were intact, and the lumen was constricted an estimated 70 per cent (slides).

Even though Owings and Hewitt were successful in only four out of 79 experimental animals in double ligation and division of the aorta, we still wonder if such would not be successful in the human if one could work under conditions not threatened by imminent rupture with fatal hemorrhage. We would like to have Doctor Blakemore's opinion on this.

DR. ALLEN O. WHIPPLE, New York: I cannot let this opportunity pass without expressing my appreciation of the work of Arthur Blakemore. He has spoken here about the stress and strain on the aneurysmal sac, but has not mentioned that on Arthur Blakemore. He worked with a method which theoretically was very complicated. His operating room for the years I was there looked like a physicist's laboratory, and he accomplished things against a great deal of difficulty. He was working in what was considered a hopeless field, and has done what he has reported without mention of the stress and strain on himself. I think it is because of his coming from old Virginia stock —they are very hardy.

DR. BARNEY BROOKS, Nashville, Tenn.: I cannot resist the temptation to compliment Doctor Elkin for calling attention to the fact that accidental injury of a large artery in the course of a surgical operation is too frequently the cause of an arterial aneurysm and mass ligation of a large artery and vein may result in an arteriovenous fistula. I can recall having operated on two arterial aneurysms of the common femoral artery produced by accidental injury in the course of an operation for inguinal hernia, and one relatively large arteriovenous fistula from mass ligature of the femoral artery and vein from thigh amputation.

Concerning Doctor Donald's paper, I would seriously question whether the enlargement of the common iliac artery was in reality an arterial aneurysm. The fact that the pulsating tumor diminished in size after closure of the arteriovenous fistula of the popliteal vessels makes it more likely that the condition, believed to be an arterial aneurysm, was in reality the great dilatation and tortuosity which occurs in an artery proximal to an arteriovenous fistula of long duration. It is also interesting to point out that operations for subclavian aneurysm have been performed in instances of a similar dilation which takes place in an artery just distal to a partial obstruction by a cervical rib.

Doctor Blakemore's presentation is a remarkable demonstration of what can be accomplished for the relief of arterial aneurysms near the base of the heart, where it appears unlikely that extirpation or the Matas operation can ever be applied. One cannot help but wonder if the excellent results obtained by Doctor Blakemore are not due to his careful study of patients before treatment, and thus his ability to obtain clotting at the most favorable site, rather than because of his modification of the Moore-Corradi method introduced many years ago. The remarks of Doctor Whipple support this idea.

Dr. J. M. T. Finney, Jr., Baltimore: In line with Doctor Elkin's paper, I felt it might be worth while to speak of a traumatic aneurysm for which I think I was responsible. This occurred in operating on a rather obese woman about 50 years of age for an acute gallbladder, through a subcostal incision, using a Deaver retractor with a rather sharp edge. The operation went along all right; it was a red hot gallbladder, which we removed with some difficulty, and we thought everything was all right. She was a chronic complainer and very nervous, and three or four times she complained of severe pain in the right flank for which we could find no reason. There was nothing in the urine, no elevation of temperature or pulse. On the 12th postoperative day she suddenly went into collapse and died before anything could be done.

At autopsy we found a tremendous retroperitoneal hemorrhage and the pathologist demonstrated a traumatic aneurysm of the right renal artery, apparently where it had been pinched by the Deaver retractor against the vertebral bodies. I do not know how common such an accident may be, but in looking back and considering how easily such a thing could happen, I wonder that it has not occurred more frequently than reports in the literature would indicate.

I was extremely interested in Doctor Blakemore's paper, because my father reported before this Association many years ago (1911*) twenty personal cases of wiring of aneurysms up until 1910. He did not have the technical refinements Doctor Blakemore had, nor did he obtain very remarkable results other than some alleviation of pain in these cases, but the methods used were rather comparable, including the passage of an electric current through the wire after its insertion in the aneurysm.

Dr. James C. Owings, Baltimore: I would like to congratulate Doctor Blakemore on the development of the method he used and the excellent results he has had in his series of cases. About 1940 Doctor Blalock suggested that I go to New York and observe his work. He was extremely kind to me, and I learned his technic in detail. I stayed several days and came home with the idea of trying the same method at Hopkins. Our problem was to develop a means of heating the wire; that took us about two years. We now have an apparatus that can be carried to any hospital or operating room and plugged into any outlet. We have treated seven cases, with not as good results as his, principally because the aneurysms have been very large and five were of the abdominal aorta. I wish to report these cases later in detail, with a description of the new apparatus, so that it will be available to anyone in the country. It is the only one available now and would have to be made by hand. By this time next year I believe I will have enough details so that anyone could have a technician build one. The patient's

* Trans. South. Surg. Assn. Vol. XXIV, 246 (1911).

pain is relieved in a most striking way. When he is admitted to the hospital he often cannot lie down, cannot sleep, and within an hour after the operation he is relatively comfortable. If nothing more were accomplished, that would be worth while.

I want to thank Doctor Blakemore for his interest and courtesy in helping me get started.

DR. DERYL HART, Durham, N. C.: A recent patient, having a traumatic aneurysm with a symptom which I had not seen before, seems worth presenting. She gave a history of having a gallbladder operation, following which her physician told her he had had to take deep sutures into the liver to control bleeding. After the operation, for a period of eight months she had occasional bleeding and drained bile from the sinus tract. Also, she had a few profuse hemorrhages from the gastro-intestinal tract, with which she went into collapse and subsequently passed tarry stools. She was studied carefully for the cause of the gastro-intestinal tract bleeding, but nothing could be found either by general examination or by x-ray studies. Because of the persistent sinus, severe pain, and the history of gastro-intestinal hemorrhage, the abdomen was explored.

The adhesions were quite dense over the bed of the gallbladder and, when these were released, there was a gush of blood and the blood pressure dropped precipitously until it was imperceptible. Large quantities of blood were given, while bleeding was partly controlled by packs while the structures were freed from the liver. We found a large laminated clot and the blood was coming through the slit between this and the surrounding structures. The clot was quickly evacuated; the blood was coming from a hole in the liver near the entrance of the hepatic duct. This hole was the size of the end of the index finger, which was inserted as a plug to control the bleeding. The cavity was palpated and was about the size of a golf ball. Even the briefest removal of the finger was followed by a gush of blood and an immediate drop in blood pressure, so that further examination was impossible. The cavity was filled with muscle as the only feasible procedure and sutures were placed through the neck of the opening to hold the muscle in place. It should be noted that compression of the portal vein and hepatic artery did not affect the bleeding.

After a week of uneventful convalescence the patient demanded her release and returned home, over the protest of the hospital personnel and her family. The dangers of further hemorrhage were explained to the patient and to her family. About two weeks later the pain recurred, she was admitted to the hospital, there was a gradual drop of blood pressure and, after about 24 hours, she died as a result of local hemorrhage.

During the past year we have had a somewhat similar case. This patient, a young man who was injured in an automobile accident, was sent in by his local surgeon because of recurring intraintestinal hemorrhages. He had had a number of attacks, each beginning with severe pain in the right flank and followed after about 15 minutes by severe drop in blood pressure and evidence of shock. Each attack was treated by blood transfusions, with relief of shock, and was followed by the passage of voluminous tarry stools. In our hospital he had recurring similar attacks, not influenced by an abdominal exploration, which was negative except for some adhesions at the site of an injury to the liver. We did not feel that a patient could bleed through the common bile duct for so long a time following an injury of the liver. However, this seemed the most likely explanation of the hemorrhages, so a second operation was performed shortly after a hemorrhage had occurred, so as to investigate the possibility of the blood passing from the liver to the intestine through the bile ducts. The common duct and the gallbladder were filled with blood, and the duct was drained in the hope of relieving the pressure and allowing the cavity in the liver to collapse. Recovery was uninterrupted, and the patient has had no further hemorrhages.

DR. JOSEPH E. J. KING, New York: I want to report briefly three cases of aneurysm of the abdominal aorta. The first was in a patient 63 years old with a large aneurysm below the renals. It bulged more to the left than to the right. I discussed his case over

the telephone with Dr. John Morton and Dr. Mims Gage and asked their advice. It was decided that a bilateral lumbar sympathectomy should be done followed by partial occlusion of the aorta above the aneurysm. The sympathectomy was performed at Lenox Hill Hospital on December 13, 1946. The aneurysm reduced to about half the original size. It was much firmer, and the excursions of the pulsation were not so great. Complete ligation of the aorta was not considered. However, on January 6, 1947, Dr. Gerald Pratt and I partly occluded the aorta just above the aneurysm and below the duodenum with two umbilical tapes tied over a double thickness cuff of fascia lata about 1.5 inches wide. The tapes were placed about five-eighths inch apart over the cuff. It was assumed that the occlusion amounted to about one-third or one-half of the lumen. Each tape was tied with three knots. The patient made an uneventful recovery. The aneurysm was somewhat reduced in size, and the patient returned to his business.

Early in March—two months after the operation—I saw him in my office and he was feeling quite well. The pain in his left side and down his left leg had disappeared. Five days later he returned to the hospital after having vomited and passed considerable blood. He was cold and clammy and in shock. Gradually he improved, and repeated small transfusions were given. He had recurring bouts of rather massive hemorrhage per rectum, each episode seemingly a little worse than the preceding. After the fifth he failed to rally, and died on April 21, 1947.

At autopsy it was found that the ligature had cut into the aorta on the anterior side and a knot had pressed through and perforated the overlying duodenum. The condition found readily explained the cause of the vomiting and passing of blood. There was no damage to the posterior wall of the aorta. (Three slides were presented showing the openings in the aorta and duodenum, and the sausage-like mold of the blood clot in the small intestine.)

About six weeks after this patient was operated upon, Dr. DeWitt Stetten had a case that was practically identical, on which he carried out the same procedure. The result in this case was the same, death being caused by perforation of both aorta and duodenum with similar signs and symptoms. (Three lantern slides were presented; these were practically duplicates of those in the first case.)

The third case was a 73-year-old gentleman, father of one of my colleagues. The aneurysm was enormous, situated above and at the bifurcation and extending downward into each common iliac artery. We contented ourselves with bilateral lumbar sympathectomy which reduced the aneurysm to almost one-half its size. The patient is up and about in the hospital, and no attempt at partial occlusion is contemplated in view of the previous experiences. Perhaps Doctor Blakemore will see this patient and advise us regarding wiring the aneurysm.

Partial occlusion of the aorta above the aneurysm by means of tape with large knots certainly is to be condemned. It is possible that partial occlusion by means of a wide, rustless steel band overlying three or more thicknesses of fascia lata might be of value, for the reason that autopsy showed marked clotting and obliteration of the aneurysmal sacs following the partial occlusion; and had the knots and thin tape not perforated the aorta and duodenum good results probably would have ensued.

I want to thank Doctors Elkin, Donald and Blakemore for their splendid papers.

DR. ARTHUR H. BLAKEMORE, New York (closing): I want to thank Doctor Whipple for his remarks and am particularly glad of this opportunity to express my appreciation of his good counsel and encouragement during the developmental stage of this work.

Doctor Finney's remarks recall the pleasant occasion of my last meeting with his father, when he expressed great interest in our new method of wiring aneurysms.

The deaths reported by Doctors Parker and King confirm what long experience has taught, namely, the dangers of applying encircling, *constrictive* devices (bands, ligatures, etc.) about the aorta. And this is true irrespective of the material employed,

because the constricting pressure alone stops circulation through the vaso-vasorum, which in turn results in ischemic necrosis ot the aorta wall.

Some years ago the late Dr. Mont R. Reid devised an experimental method of occluding the dog's aorta which embraced the principle of endoarterial occlusion. He introduced a ball of fascia lata through a small longitudinal incision in the aorta and retained the ball in place by two through-and-through mattress sutures. Retaining the principle of endoarterial occlusion, we have devised a method that has proven clinically satisfactory for the progressive closure of the aorta without damage to the vaso-vasorum or the aorta wall. Our method is employed in conjunction with wiring and electrothermic coagulation and is ideally suited to the treatment of arteriosclerotic aneurysm of the abdominal aorta because of its atraumatic features.

In applying our method of progressive endoarterial occlusion with electrothermic coagulation for the treatment of arteriosclerotic aneurysm of the abdominal aorta our present policy is to do first a sympathectomy on the right side. After an interval of ten or more days, a sympathectomy is performed on the left and, through the same incision, the abdominal aorta and the upper part of the aneurysm are exposed.

Since the arteriosclerotic aneurysm almost invariably arises from the abdominal aorta three or more centimeters distal to the origin of the renal arteries, it is feasible to place the obstruction in the aorta immediately proximal to the aneurysm.

Accordingly, a special needle is introduced into the aorta at a point three or more centimeters proximal to the aneurysm and directed obliquely distalward. Fine (No. 34 Ga. B&S), coin silver wire coated with polyethylene containing an irritating plasticiser is passed through the needle into the aorta. Compression of the aorta at the aneurysm junction during the passage of the wire confines it to the aorta and forces the formation of a self-retaining ball of wire immediately proximal to the aneurysm.

As more and more wire is concentrated in the ball, the physical state of turbulence is engendered in the on-rushing blood. The effect of turbulence of the blood, with its hundreds of colloding streams, is to iron out the systolic thrust (pulse wave) before it reaches the aneurysm proper. This effect largely eliminates the "see-saw" pulse strain upon the sac wall of the aneurysm—this is quite a factor in the average arteriosclerotic who, in the absence of elastic recoil in the artery walls, carries oscillometric readings two, three, or more times normal values.

During the passage of the wire for its impedence effect, an oscillometer placed upon the leg satisfactorily registers the decline in pulse pressure—a 50 per cent reduction is the desired amount. After a sufficient amount of wire is passed, the ends of the wire are pushed through the needle with a stylet.

Finally the needle is advanced distalward in the aorta through the ball of concentrated wire well into the aneurysm. At this level two or more 10-meter segments of insulated wire are well distributed within the aneurysm proper. Each segment of wire is heated to 80° C. for a 10-second period. The heat causes a protein coagulum to form upon the wire which, in turn, stimulates blood clotting within the aneurysm. Also, raising the temperature of the wire to 80° C. by passing a direct current through the wire, causes subsequently a heat inflammation in the sac wall of the aneurysm. This helps to promote organization of the blood clot and thus strengthen the aneurysm against sudden rupture of subsequent growth. After heating the respective segments of wire, the ends of the wire are pushed through the needle into the aneurysm and the special needle is withdrawn.

Finally, a film of polyethylene containing an irritating plasticiser is placed about the aorta overlying the exact site of the ball of wire within the aorta. The surrounding tissues are protected from the irritating effects of the above film by covering it with a film of pure polyethylene, which is not irritating to tissues. The plastic film is placed loosely about the aorta so as not to cause pressure necrosis of the wall but to stimulate fibroplasia about the wall of the aorta. Immediately within, the aorta wall is in contact with plastic coated wire which causes a similar reaction. Thus, gradually, over a period

of weeks, the process of fibrotic constriction of the aorta takes place at the site of election immediately proximal to the aneurysm at no time offering the threat of sudden hemorrhage from pressure necrosis of the aorta wall.

The above described procedures may be carried out without the necessity of ever really touching or disturbing the aneurysm. This is an important consideration when dealing with arteriosclerotic aneurysms which are prone to develop weakened areas of anemic necrosis of the sac wall. It is this characteristic pathologic feature, in combination with the abnormally high pulse pressure of the arteriosclerotic, that makes this type of aneurysm far more liable to sudden rupture than the syphilitic variety of aneurysm.

To summarize: The combined operation effects a lessening of strain upon the aneurysm by (1) lowering systemic blood pressure (sympathectomy); (2) elimination of the abnormal pulse pressure through the creation of turbulence by the introduction of a ball of wire into the aorta immediately proximal to the aneurysm; (3) reduction of the surface area of the aneurysm by clotting. The aneurysm is strengthened by the promotion of fibroplasia, clot organization, the result of heat inflammation. Finally, the induction of chemical inflammation through the employment of polyethylene containing an irritating plasticiser in contact with the aorta wall immediately proximal to the aneurysm, sets the stage for progressive endoarterial occlusion.

When dealing with large, rapidly growing arteriosclerotic aneurysms of the abdominal aorta, it may be wise, after a three to six months interval, to do a second stage procedure. At this operation an aneurysm which has become well supported by clot from a previous procedure may be safely approached transperitoneally through a left rectus incision. At the second stage, as indicated, the following may be accomplished: (1) Introduction of additional plastic (polyethylene) coated wire into the aorta immediately proximal to the aneurysm for its impedence effect; (2) Introduction of additional segments of insulated wire into the aneurysm for heating, in areas where more clot is desirable; (3) In those cases having considerable clot within the aneurysm it is safe to reflect the peritoneum lateralward and apply polyethylene film containing an irritating plasticiser about the anterior and lateral portions of the aneurysm. This film is, of course, overlaid with a non-irritating film of pure polyethylene to protect the overlying peritoneum.

Doctor Owens, with the aid of his talented engineer brother-in-law, has constructed a compact heating unit that is satisfactory for the electrothermic method, if due caution is taken against overheating the wire. Doctor Owens is a most careful operator, and I shall expect of him excellent results. Though our equipment is more cumbersome, the ratiometer employed by us does indicate the exact temperature of the wire at all times during the heating period.

ENDOMETRIOSIS*

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PERHAPS IT IS UNNECESSARY to write again upon the subject of endometriosis. However, after many years of careful observation of this phenomenon certain definite ideas have arisen as to its cause, its treatment, and its significance. The conclusions drawn by one interested in the subject for 26 years may be of help in solving a surgeon's reaction to the treatment of some of the problems presented. There can be no doubt about the great frequency of endometriosis. So many of these endometrial lesions are found in patients who have no symptoms attributable to their endometriosis, that it is logical to feel that most endometriosis simply represents abnormal physiology and not true disease. It is possible that it has even increased in frequency but the apparent increase may be due to the more careful observation of and to more careful selection of tissue for the pathologist. To me it seems to be much more evident than ever before. In 1922, one year after the time of John A. Sampson's epoch-making studies of the disease, I was assistant to the late Dr. William P. Graves at the Free Hospital for Women in Brookline, Massachusetts. Dr. Graves was extremely interested in the problem presented by Dr. Sampson and a careful search for endometrial lesions brought very few results. Later, as assistant to the late Dr. George W. W. Brewster, we were still unable to find frequent endometriosis. Within the last ten years the author has found that a very large percentage of his gynecologic cases operated upon for various reasons have the tell-tale small, blue to black, puckered areas and that after excision of such areas and microscopic study by the pathologist a diagnosis of endometriosis could be made. It is possible that better exposure of the deep pelvis because of the routine introduction of total hysterectomy allowed areas in the region of the utero-sacral regions to be more carefully observed. It is probable that the routine excision of these small suggestive spots and the fixing of them in small bottles for the pathologist has raised the number of correct diagnoses. At the present time it is rare that the suspicion of endometriosis of a given area is not confirmed in the laboratory. If the small, puckered areas are not removed and fixed separately, it is most difficult for the pathologist to find the areas when the removed uterus arrives in the pathologic laboratory. The excised uterus, shaggy and covered with blood, hides the tiny, dark, pigmented areas nearly completely.

FREQUENCY

In the second private series (Table I) reported in this discussion 35 per cent of the cases operated upon abdominally for varied gynecologic complaints, have endometriosis. The second series reported from the Massachusetts General Hospital (Table I) shows an 8.25 per cent involvement. This discrepancy

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Tuesday, December 9, 1947.

TABLE I

	Consecutive Cases	Endometriosis Microscopically	Endometriosis Grossly	Endometriosis Microscopically or Grossly
Private—I.....	400	112–28%	32–8%	144–36%
Private—II.....	400	122–30.5%	18–4.5%	140–35%
M.G.H.—I.....	400	21–5%	11–3%	32–8%
M.G.H.—II.....	400	23–5.75%	10–2.5%	33–8.25%

may be due to the fact that our Resident Surgeons and Assistant Resident Surgeons, who do a considerable amount of the surgery, are not sufficiently interested in or acquainted with the disease. However, during the period of the second series most of the young surgeons have been assistants on my private service and have done their own surgery in the newly established Vincent Memorial Hospital Gynecologic Service in our hospital. With the House Staff's careful gynecologic supervision and after frequent discussions of this problem, the percentage of endometriosis in the ward group has not increased. I do not believe that this is due to lack of careful observation or lack of interest, but rather to a difference in attitude toward child bearing among private patients and ward patients. Private patients marry and have children later than those in the wards of the hospital. This difference will be further discussed under the heading of *etiology* below. The areas involved by endometriosis (Table VIII), and this paper is not concerned with adenomyosis of the uterine wall, are many. The ovary, the tube, the peritoneum covering the uterus, the anterior bladder flap, the uterosacral ligaments, the round ligaments, the umbilicus, the rectovaginal septum, the sigmoid, the small intestine, the appendix, as well as other areas have been found to be involved. It is interesting to note that practically all of the lesions are within the pelvis, thus proving a relation to the pelvic celom.

ETIOLOGY

Endometriosis may have various causes and it may be impossible accurately to determine its etiology. Several outstanding theories have been presented. Cullen showed that adenomyosis is due to a down growth of the endometrium into the uterine musculature. In 1897 he reported his first case of adenomyoma of the uterus.[6] His work has never been refuted and his view is accepted as explanation for this type of aberrant endometrium. Adenomyoma, although aberrant endometrium, is not what we are discussing today. In 1897 Pfannenstiel[24] reported a case of endometriosis of the rectovaginal septum and in 1899 Russell,[25] of the Johns Hopkins Hospital, reported the finding of endometrial tissue in the ovary. In 1909 Meyer reported a case of endometriosis of the bowel.[20] In 1921 came the first enlightened explanation for aberrant endometrium, in a painstaking study by Dr. John A. Sampson of Albany.[26, 28, 29, 30, 31] His numerous ideas include, first of all, his famous tubal reflux theory and the suggestion that tubal epithelium may become acti-

vated as endometrial tissue does and produce menstruating lesions. He also suggests the possibility of lymphatic drainage as responsible for extension of the disease. His suggestion that cast-off endometrium at menstruation may flow through the tubes, adhere to and grow in the ovary or in the pelvis, is a highly provoking thought and may be responsible for some endometrial lesions. Endometriosis as a rule occurs after the age of 26 (Table II), thus giving plenty of time for many menstrual refluxes to occur. Interestingly enough, the fimbriated ends of the tubes are nearly always open in endometrial lesions. Only very occasionally have we found the tubes closed and it is possible that the endometrioma started to grow before the tubes were closed. Blood has often been seen flowing from the tubal ostium, and photomicrographs have demonstrated endometrium in the tubal lumen. It is difficult, however, to believe that cast-off endometrium is living and can be implanted on other tissues as in a skin graft. Experimental work along this line has not been conclusive enough to support his idea of the growth of cast off endometrium. Bartelmez[1] states that microscopic inspection of cut sections of the uterus in its entirety during menstruation shows viable endometrium in the uterine canal. Markee's work[17] in experimental transplantation of endometrium into the eye of the monkey is definitely against the reflux theory. He has been able to transplant endometrium into the eye easily yet he has never, in many experiments, seen a piece of cast-off menstruating endometrial tissue in the eye attach itself into the chamber of the eye and grow. Sampson's reflux theory is probably not the most significant etiologic factor in most cases of endometriosis. Von Recklinghausen's theory that endometriosis arises in the left-over pieces of the Wolffian ducts has been discarded. Halban[9] has suggested that normal endometrium can metastasize through the lymphatics. This theory may account for the lesions found in the lymph nodes of the pelvis and in the groin.[27] One definite case of endometriosis reported in the pleura[4] supports his theory. Halban's theory is a good one and yet it is doubtful that it can explain the nodules so frequently encountered in the pelvis and in the pelvic organs. Iwanoff of Russia[12, 13] and Meyer[21] of Germany independently believe that endometriosis is due to the stimulation of growth of embryonal cells of the celomic epithelium. The celomic epithelium is also responsible for the epithelium of the upper vagina, the endocervix, the endosalpinx, and the covering of the ovary. Iwanoff and Meyer postulate that under certain conditions, such as inflammation or injury or irritation due to menstrual blood, that embryonic cells of the celom may grow and produce Muellerian and hence endometrial tissue. This theory, or the interpretation of this theory, seems to be a satisfactory explanation of endometriosis. It even accounts for the finding of endometrium in the forearm[23] in one case and in the thigh in two cases.[16, 32] The arm and leg buds in the embryo contain celomic epithelium and left over cells from these buds may grow and produce endometrium. In our observations of endometriosis, under-development of the pelvic organs is frequently present. Under-development of pelvic organs suggests the presence

TABLE II.—*Ages*

	Endometriosis				No Endometriosis			
	Private		M.G.H.		Private		M.G.H.	
	Series I	Series II	Series I	Series II	Series I	Series II	Series I	Series II
10–19	..	..	..	3.03%	2.38%	1.9%	6.2%	4%
20–29	4.3%	8.6%	18.8%	3.03%	8.09%	9.2%	23.8%	15.5%
30–39	34.3%	25%	21.9%	42.42%	26.66%	31.6%	28.7%	33%
40–49	51%	55.7%	31.25%	36.36%	43.33%	50%	28.4%	39%
50–59	9.5%	10%	25%	15.15%	11.9%	7.3%	8.7%	8.1%
60–69	.93	.7%	3.1%	..	5.7%	4.68%	3.3%	.3%
70 plus					1.9%		.8%	

TABLE III.—*Symptoms*

	Private		M.G.H.	
	Series I	Series II	Series I	Series II
	144	140	32	33
Pain not dysmenorrhea	32.6%	26.4%	43.7%	48.48%
Acquired dysmenorrhea	12.5%	26.4%	9.3%	30.3%
Infertility	32.9%	36.1%	7%	..

of inactive, embryologic, left-over cells which would increase the percentage of endometriosis. Patients with dysmenorrhea, for instance, frequently have endometriosis and many patients with dysmenorrhea have small and underdeveloped organs. Those patients with the so-called "congenital erosion" of the cervix frequently have endometriosis. Thus it would appear that the celomic epithelium rest theory has a good deal in its favor. Upon Iwanoff's and Meyer's conception rests our theory and understanding of endometriosis. It is our opinion that endometriosis occurs because of a lack of early and lack of frequent child-bearing (Table V). How does this affect the problem? In nature certainly early child-bearing and frequent child-bearing is the usual thing. This may be prevented by untoward circumstances, such as caging and domestication. Certainly some monkeys who menstruate, as women do, mate early following the menarche and have offspring, nurse, and then become pregnant again. In their natural habitat they probably follow this sequence until they either physiologically can have no more offspring or die. This is what nature expects of animals. The human being does not carry out nature's rules. Our grandmothers and great grandmothers probably more nearly approximated the ways of nature than the modern women, at least up to World War II. For a number of years, due to economic conditions, young people have not been able to marry early and if married, found it necessary to prevent pregnancy. This allowed many menstrual cycles to occur (Table VI) and the varied hormonal reactions of menstruation porbably stimulated the celomic cells to grow and produce Muellerian growth. Certainly menstruation is not supposed to occur monthly for years without interruption. Menstruation is an indicator to the young woman that she is not pregnant. It is unlikely that women with ten or more children menstruate frequently. Late and infrequent childbearing is not normal physiologically. It is likely,

therefore, that this abnormal physiology may have some definite effect upon the pelvic celomic tissues. It will be noted in this study (Table V) that most patients with endometriosis have none, or one, or two children, and the greatest number falls into the group who are denying their normal functions. Dr. Thomas R. Goethals[8] demonstrated that the primpara of his private practice fall into two groups: 25 years old and under, and 26 years and over. Seventy per cent of 200 patients were in the older group and became pregnant for the first time at or after the age of 26. This group then, assuming that they had the menarche at 14, menstruated for 12 or more years without interruption. This is certainly not normal and if the celomic epithelium contains cells capable of

TABLE IV

	Private		M.G.H.	
	Endometriosis	No Endometriosis	Endometriosis	No Endometriosis
Series I	144	256	32	368
Single	41–28.5%	56–21.9%	4–12.5%	62–17%
Married	103–71.5%	200–78.1%	28–87.5%	306–83%
Series II	140	260	33	367
Single	33–23.6%	41–15.9%	5–15.1%	52–14.16%
Married	107–76.4%	219–84.2%	28–84.8%	315–85.83%

TABLE V

	Endometriosis		No Endometriosis	
	Private	M.G.H.	Private	M.G.H.
Fertility of married group				
Series I	66.9	93%	83.1%	88.5%
Series II	63.8%	100%	77%	85.4%
Two children or less				
Series I	73.6%	43.4%	53.2%	50.3%
Series II	79.1%	67.8%	57.39%	38.7%
Age at marriage 25 or over				
Series I	53.7%	16%	37.6%	17.9%
Series II	57%	11%	37%	21%
Age at first child 25 or over				
Series I	60%	23.5%	..	..
Series II	69.8%	14%	55.4%	30.9%

producing endometrial epithelium, it had plenty of time to do so. Dr. John Fallon of Worcester, Massachusetts[7] recently stated that a woman should have a child at least every five years to prevent the onset of endometriosis. It has always seemed to me, believing in this theory since it was suggested in an editorial in *Surgery, Gynecology and Obstetrics* in 1938,[18] that if women had their children when they were young, its subsequent development after they had had their children, would not be of too great importance. It is suggested that the celomic epithelium theory of Iwanoff and Meyer is correct and that the growth of endometrial cells is due to an abnormal physiology and

that this abnormal physiology is late and infrequent childbearing. This well considered etiologic factor is introduced as an addition to the many suggested reasons for the frequency of endometriosis.

SYMPTOMS

The symptoms of endometriosis are well known and do not need elaboration. Dysmenorrhea especially of an acquired type, pelvic pain, infertility, and abnormal menstruation in the form of too much bleeding are the usual symptoms (Table III). Pain in the groin or umbilicus due to an endometrioma in that region is rare but understandable. Periodic attacks of intestinal obstruction at the time of the menses sometimes occur. Cyclic bleeding from the rectum was formerly thought to clinch the diagnosis of endometriosis of the bowel, but it is obvious from a study of the roentgen-ray findings in these cases and of the tumor after resection, that there is no break in the continuity of the bowel mucosa over the lesion and, therefore, bleeding should *not* take place. Fallon has demonstrated that endometriosis can occur in a much earlier age group than has usually been considered. Surgeons who operate upon young girls for pelvic pain, and who have been forced to consider the diagnosis of chronic appendicitis, should carefully inspect the pelvis. According to him, endometriosis may be found to be the cause of the symptoms.

DIAGNOSIS

The diagnosis of endometriosis may be suggested by the symptoms and, if in addition to the symptoms typical physical evidence is found, the diagnosis should be easy. The easiest clue to the diagnosis on physical examination is a rough, firm, and "shotty" feeling behind the cervix which is best felt by rectal examination. The "shotty" nodules in the uterosacral ligaments can be easily felt and in my experience this is the earliest and most frequent physical finding in this disease. If the lesion is more widespread and if the ovaries are involved and adherent, the vaults give the same shotty feeling and occasionally a cyst with a soft spot, the area of its adherence to the broad ligament, may be felt. Proctoscopy with the expectation of viewing an endometrioma of the bowel is not successful. The involvement of the bladder, however, can be easily observed by cystoscopy. If a firm nodule is felt behind the cervix on the vaginal side, inspection of this area may easily show a group of small, black to blue nodules and clinch the diagnosis of endometrioma of the rectovaginal septum.

To make the definite and microscopic diagnosis of endometriosis let me stress the importance of the surgeon, at the time of operation, excising the small, suspected areas and placing them in a fixative for examination in the laboratory.

TREATMENT

The treatment of endometriosis is clear-cut (Table X). Inasmuch as an endometrioma as well as the endometrium is under the control of the ovarian hormones, castration will always check the progress of the lesion. This is a

satisfactory and correct treatment in the older age group, especially if the endometriosis is so extensive that it may injure another organ, for example the bladder, the bowel, or the ureter. However, in a girl who has had no children and wishes them, such radical treatment as castration is to be deplored. In these days of accurate, careful, safe surgery it is far better to resect the bladder or intestine, to resect or transplant the ureter, than to castrate a girl who wishes children and who is at the age where her sexual relations may mean her happiness.

Endometriosis is a slowly growing process, and it may take years for it to advance to a large size. It is rare to see a chocolate cyst greater than a small orange. Endometriomas of the peritoneum, usually very small, rarely are larger than 1 centimeter. They may become widespread and may pucker up

TABLE VI

	Private		M.G.H.	
	Endometriosis	No Endometriosis	Endometriosis	No Endometriosis
Marriage to first pregnancy 2 years or more:				
Series I	62.2%	53%	540%	41.1%
Series II	66.1%	55%	6.7%	40%
Menarche to first pregnancy 10 years or more:				
Series I	55.5%	67.3%	38.4%	35.9%
Series II	79%	72%	31.6%	39.8%
Menarche to endometriosis 17 years or more:				
Series I	93.3%		75%	
Series II	89.4%		96.3%	

the peritoneum but they never become large enough to endanger the patient's life. As a matter of fact, it is probable that many of these lesions are in an end stage when seen. Most endometriomas are surrounded by scar tissue, as shown by Sturgis,[33] and pain is caused by slight activity and swelling in a small number of endometrial glands that may be active. Most endometriomas contain inactive endometrium and do not enlarge. It has been my privilege recently to reoperate upon a patient who had endometriosis in the uterosacral ligament seven years before. Sufficient tissue, but not all, was removed to make the diagnosis at that time and yet at this examination the endometriosis left behind had not changed in the seven years. If many of these small lesions are inactive, it is wrong to castrate patients for endometriosis. The operation for endometriosis should be done for pain, not simply because endometriosis is found. Most large chocolate cysts are probably not active or, if so, are active in only a few places, for microscopic examination, according to Sturgis, shows that the epithelium is cuboidal and no longer cylindrical. These lesions did menstruate but the menstrual fluid under pressure has flattened the epithelium, and activity has ceased. Surgery is correct if an ovarian lesion is suspected

and endometriosis cannot be accurately diagnosed, for it is far wiser to operate and find a small cyst than to let a cancer of the ovary grow. If a woman is young and wants children, the treatment for the chocolate cyst is excision of the cyst from the ovary. This is very easy to do, and the cyst wall will shell out just like a follicle cyst, and the ovaries can be easily reconstructed. In endometriosis the posterior cul-de-sac is often pulled up on to the back of the uterus. This fact should be recognized and after the cul-de-sac is released a proper uterine suspension should be done to keep the pelvic organs away from the raw areas in the deep pelvis. This adherence of the cul-de-sac with its obliteration of the uterosacral ligaments should be well considered before total removal of the uterus is contemplated, for the rectum can be easily entered here. This adherent tissue is characteristic of endometriosis. The cul-de-sac can best be released if the uterus is pulled up tight with a double hook—the area of adherent growth frequently splits, and the cul-de-sac will begin to separate; if it does not, by placing the edge of a knife against the adhesive area it will start the split and the cul-de-sac can quickly be freed from the uterosacral ligaments and back of the cervix and posterior wall of the vagina.

In women with ovarian endometriosis, when it seems wise to spare ovarian function, it is perfectly satisfactory to remove the uterus and cervix and the larger ovary with its cyst but to resect the cyst from the other ovary and leave it behind with its tube. Inasmuch as the disease progresses slowly, if symptoms should recur, roentgen-ray treatment will stop ovarian function and thus cause a cessation of the growth of the endometriosis. In nearly all instances conservative surgery with preservation of ovarian function should be the guide to treatment, and castration should be reserved for those lesions that are too difficult to solve by conservative surgery. We have had the opportunity to observe two cases of endometriosis of the rectovaginal septum following castration, and it was three years before the lesions finally became white and disappeared, leaving only a very slight puckering in their place. Slow growth and slow disappearance seems to be the rule.

In bowel endometriosis, if the lesion is found accidentally and the patient has no intestinal symptoms, castration is best in the older age group and resection of bowel for the young woman, and especially for the young woman who wishes children and is in the child bearing age. A good test to determine the result of treatment, if bowel symptoms only are present at the time of operation, is the use of an estrogen to prevent ovulation. If the distention of bowel or if pain in the pelvis is rhythmic and accompanies a normal period it is possible by preventing ovulation with estrogen to produce an abnormal period and thus prevent the occurrence of symptoms. Relief of symptoms demonstrates that it is wise to castrate the patient and to expert relief of distention and pain. This test is very satisfactory in determining whether or not a patient's pain is made worse by the menstrual cycle, for by preventing ovulation a normal secretory endometrium and normal cycle is avoided. If

pain is prevented, then the cycle is responsible, but, if there is pain at the time of withdrawal bleeding, it is not connected with the menstrual cycle.

It has been suggested by Hirst of Philadelphia,[10] and Miller of Hartford,[22] that testosterone is a satisfactory treatment for endometriosis. Amenorrhea may be caused by this treatment for 2-3 months. It is said that the lesion softens and in some patients who were sterile, fertility followed, and in some cases operation was made easier. Kanarky from Houston, Texas,[15] advocates large doses of stilbestrol for the same purpose. It is very difficult to see how

TABLE VII.—*Region of Endometriosis*

	Private		M.G.H.	
	Series I 144	Series II 140	Series I 32	Series II 33
Ovary	86–59.7%	74–52.8%	11–34.4%	21–63.8%
Uterosacral ligament	31–21.5%	59–42.1%	3–9.3%	2–6.06%
Peritoneum	8–5.6%	13–9.2%	1–3.1%	2–6.06%
Bowel	9–6.25%	6–4.3%	2–6.25%	2–6.06%

TABLE VIII.—*Regions of Endometriosis*

	Private		M.G.H.	
	Series I 144	Series II 140	Series I 32	Series II 33
Ovary	86–59.7%	74-52.8%	11–34.4%	21–63.8%
Uterine surface	64–44.4%	34–24.2%	21–65.6%	8–24.2%
Cervix		2–1.4%	1–3.1%	1–3.03%
Uterosacral ligament	31–21.5%	59–42.1%	3–9.3%	2–6.06%
Peritoneum	8–5.6%	13–9.2%	1–3.1%	2–6.06%
Tubes	12–8.3%	9–6.4%	1–3.1%	3–9.09%
Cul de sac	5–3.5%	7–5%	3–9.3%	6–18.1%
Appendix	1–.7%	3–2.1%	1–3.1%	1–3.03%
Bowel	9–6.25%	6–4.3%	2–6.25%	2–6.06%
Round ligament	4–2.8%	1–.7%		
Lymph nodes in iliac area		1–.7%		
Umbilicus			1–3.1%	
Rectovaginal septum	2–1.4%		1–3.1%	
Vagina			1–3.1%	

the use of any hormone can influence a lesion that is in an end phase and a lesion that takes three years to vanish; nevertheless, for the purpose of discussion, this newer method of treatment should be mentioned.

In the treatment of the dysmenorrhea of endometriosis it has often been suggested that a presacral neurectomy be done, and in those patients who have central pain and not lateral pain a presacral neurectomy is satisfactory if conservative surgery is contemplated. It is best to do the neurectomy before the endometriosis is disturbed, to prevent spilling endometrium into the retroperitoneal wound. Dr. Willard Cooke of Galveston[4] advocates cutting the infundibular pelvic ligament to enervate the ovary in lateral pain but inasmuch as this destroys two thirds of the ovarion blood supply, it cannot be advised.

RESULTS OF TREATMENT

The results of conservative treatment are very satisfactory, and it is rare that an operation has to be repeated. This suggests that in most instances the lesion is very slow to progress. Re-operation has been reported as necessary in from 9 - 29 per cent in various clinics. In our clinic with conservative methods, it is indeed rare. In from 9 - 29 per cent of reported cases a preg-

TABLE IX

	Private 144	M.G.H. 33
Type of endometrium:		
Secretory	46–32.8%	9–27.27%
Early secretory	5–3.6%	1–3.03%
Late secretory	1–.7%	1–3.03%
Proliferative	47–35.5%	8–24.24%
Early proliferative	1–.7%	
Late proliferative	2–1.4%	
Senile cystic	1–.7%	
Inactive	5–3.6%	1–3.03%
Atrophic	2–1.4%	1–3.03%
Negative	5–3.6%	
Menstruating	1–.7%	
? type	24–17.1%	12–36.36%

TABLE X.—*Surgery*

	Private		M.G.H.	
	Series I 144	Series II 140	Series I 32	Series II 33
Endometriosis cases:				
Radical (both ovaries removed)	57–39.6%	12–8.6%	17–53.1%	8–24%
Conservative (conservation of ovaries)	87–60.4%	128–91.4%	15–46.9%	25–76%
No endometriosis:	256	260	368	367
Radical (both ovaries removed)	72–29%	18–7%	98–26.6%	39–11%
Conservative (conservation of ovaries)	183–71%	242–93%	270–73.4%	328–89%
Conservative for Pregnancy:				
Endometriosis cases:	144	140	32	33
Conservative	21–14.6%	16–11.42%	4–12.5%	5–15.1%
Pregnancy following	6–28.6%	2–12.5%	..	..
Radical (uterus with or without ovaries)	123–85.4%	124–88.5%	28–87.5%	28–84.8%
No endometriosis:	256	260	368	367
Conservative	52–20.3%	38–14.6%	119–32.3%	90–24.5%
Pregnancy following	5–9.6%	..	3–2.5%	..
Radical (uterus with or without ovaries)	204–79.7%	222–85.4%	249–67.7%	277–75.5%

nancy has followed conservative surgery (Table X). This is most satisfactory, and it is possible that this per cent of fertility can be improved. Patients with endometriosis are sterile because the ovary is fixed and the normal interplay of tubal and ovarian movement is prevented. The egg cannot be deposited into the fimbriated end of the tube, as it should be. The tube is fixed in an abnormal position. It is, therefore, important that patients be advised to try to become pregnant very soon after conservative operation. If the tubes and ovaries are free, better results can be expected than if they are firmly adherent.

THE SIGNIFICANCE OF ENDOMETRIOSIS

The significance of this lesion is that it is probably due to lack of early childbearing and infrequent childbearing. It is due to lack of normal use of the female organs, thus allowing abnormal physiologic processes to persist. There is great need in these times for financial aid to *our* daughters and sons, and it is my opinion that financial help to our children will reduce the incidence of endometriosis and will also reduce the incidence of unhappy and childless marriages. In the present economy of our country it is nearly impossible for a young man to make enough money to support his wife. Therefore it is up to all as fathers and mothers to permit our children to marry early and to aid them financially until they are able to care for themselves. In some instances this will be impossible for fathers to do. *Our* children must realize that by being helped when young they need not expect much in the way of an inheritance. Our children will not need help later, for if they are sufficiently able they will be able to support themselves and will not need or expect any money to be left to them. Help when they are young is very important and by supporting their marriages and helping the young wife to have her family we will accomplish much more for the world than we will by trying to save for them when they get older. The idea of better pay for young men should be taken into account in industry, and workers should be paid more earlier in life and not expect great increases in their salaries or earning capacity as they get older. The level of income should be increased for young men with wives. They should be encouraged to keep our country populated by having children when they are young, and not allowing them luxuries when they are older. This philosophy for our children is an extremely important one, and larger pay will not be necessary when they are older. I hope that it may strike a responsive note among the members of this association.

DISCUSSION

Endometriosis is one of the most common and most talked of pathologic lesions, not only in gynecology but in surgery. It is replacing the surgery of the "cyst of the ovary." Cyst surgery is going out of existence in most parts of the country. Surgery for endometriosis should be done only for definite reasons, and significant symptoms are the real guides for such surgery. Just as certain fibroids should not be operated upon, so certain patients with endometriosis need not be operated upon. The excellent prognosis of this condition, the fact that in most cases the activity when recognized is over, means that unless there are definite symptoms such as sterility, severe dysmenorrhea, and intestinal obstruction cases with endometriosis can be watched, just as well as patients with small fibroids.

THE MATERIAL

In this paper, attention is drawn to the comparison between two series of 400 private patients and two series of 400 Massachusetts General Hospital patients.[19] The first series of patients were collected in the years 1936-1941,

TABLE XI.—*Last Pregnancy to Endometriosis*

	Private		M.G.H.			
	Series I	Series II	Series I	Series II		
Fertile	65	67	26	28		
Less than 1 yr.			1			
1 yr.	1	3				
2 yrs.	1	4	2			
3	1	2	2	1		
4		3	1	3		
5		1	2			
6	2	1	1	3		
7	1		2	1		
8	4	3	1			
9	1	2		2		
10	5	2	3			
11	1	6	1	2		
12	5	5		1		
13	2	4	2	1		
14	2	3	1	2		
15	2	4		1		
16	4	5				
17	1	3		1		
18	6	1		1		
19	3		1	1		
20	3	1				
21	1	5				
22	2				1	
23	1	1				
24	2	2			1	
25	1	2				
25 plus	5	1	2	3		
?	8	3	4	3		

and the second, 1945-1947. It is evident that most patients with endometriosis are from the more well-to-do group. Also it is evident that late childbearing is the choice of private patients as compared to earlier marriage and many children among the ward patients. This investigation was carried out to prove that the first comparison was not a misconception and that the same trend is evident in the latter series as in the early ones. It is possible that there will be a definite difference in the next five to ten years for the war years produced earlier marriages and childbearing. It will be interesting to see if that group of young women who married early and had children are as frequently affected with this usually innocuous but sometimes frightening disease. The tables explain the results and a careful perusal of them indicates that the trends are as they have been presented.

CONCLUSIONS

1. Endometriosis is a common disease and the surgery of endometriosis is supplanting surgery for "cyst of the ovary."

2. Endometriosis is not such a frightening lesion as has previously been considered.

3. The stage in which the disease is seen is often at the end of activity.

4. Endometriosis by interfering with the normal motion of the tubes and ovaries may interfere with fertility and as such should be corrected.

5. Resection of ovarian endometriomata and conservation of ovarian tissue is essential in young women both for childbearing function and for sexual function.

6. The theory of the growth of the celomic epithelium due to delay in childbearing is the most important etiologic factor in endometriosis.

7. Radical surgery should be rare in endometriosis.

8. Endometriosis of the bowel should be treated by resection and not castration in young women.

9. The economic condition of the world behooves us as parents to help our children financially to marry early and have children. It is suggested that higher wages be given to young married couples.

10. Endometriosis may be aided by treatment with testosterone or by stilboestrol, but this treatment is not permanent.

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DISCUSSION.—DR. WALTER R. HOLMES, Atlanta, Ga.: I have enjoyed hearing Doctor Meigs' paper and the discussion on endometriosis. I would like to agree with and emphasize his conservative attitude in regard to the treatment of this disease. I am convinced that in the majority of patients on whom a diagnosis of endometriosis is made surgical interference is not necessary. Patients having endometriosis deserve a frank discussion of their condition, with explanation of the cause of their premenstrual discomfort and other pelvic symptoms. Intelligent patients will often prefer to endure their discomfort rather than be subjected to a mutilating pelvic operation. In the child-bearing period where operation was necessary, conservative surgery was rewarded by subsequent pregnancies in 12 per cent of my private patients. In the more advanced stages of the disease, complicated by fibroids and adenomyosis, hysterectomy with preservation of some ovarian tissue has given uniformly satisfactory end results. Although bilateral oophorectomy will cause regressive changes in endometriomas, the cure is often worse than the disease. There is no more tragic human figure to haunt our reception rooms than these castrated derelicts of femininity.

Doctor Meigs' theory that early marriages and early pregnancies will prevent endometriosis is extremely interesting. The parental financial aid suggested by Doctor Meigs, to make it possible for young people to marry early, if carried out, would certainly be a great boon to future sons-in-law and daughters-in-law.

DR. JOHN C. BURCH, Nashville, Tenn.: Endometriosis is a disease which is not as progressive as formerly thought. I agree with Doctor Holmes that observation and conservative treatment are indicated in most instances. It is an infiltrative disease with

a very low malignant potential. On account of its infiltrative nature it is almost impossible to remove the process by local excision. Furthermore, progress of the lesion is dependent upon hormonal stimulation by the ovaries. It seems wise, therefore, to approach the case from its physiologic aspect and to ascertain the functional needs of the patient.

Many times it is impossible to dissect the cyst from the ovary and leave any functioning ovarian tissue. Open the cyst and depress it and the ovary in many instances will return to normal function. I had an illuminating experience some years ago. The patient was a woman of 25, engaged to be married, who had an ovarian cyst. At operation a large chocolate cyst was found in the left ovary and one on the right. I felt it would be a terrible thing to make a clean sweep. I simply decompressed both cysts, closed up, and in three months she was married and in 15 months was a mother.

DR. ROGER G. DOUGHTY, Columbia, S. C.: I simply want to add my voice to the conservative attitude in the treatment of endometriosis, based originally on an experience I had in 1924. The patient was a young woman with extensive endometriosis. In the course of operation, having been impressed with the necessity of removing the ovaries in such cases, I hesitated, and finally wound up by removing as much as I could of the diseased tissue, but leaving both ovaries. She married about two years later, has had three or four perfectly normal children and has had no difficulty in the pelvis. Following that experience I have been extremely conservative in handling endometrial lesions and, most of the time, do not do even a hysterectomy, let alone an oophorectomy. I have not had cause to regret this attitude through the years.

THE CLINICAL EVALUATION OF CHOLANGIOGRAMS*

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THE POTENTIAL VALUE of cholangiography was emphasized several years ago by Mirizzi[1], Saralequi,[2] Best and Hicken,[3] Walters and Snell,[4] and many others. Since that time the value of the "delayed" cholangiogram has been established beyond question, and its routine use is general and well known. The "immediate" cholangiogram has had a limited trial and is rarely used, because of technical difficulties and the lack of easy access to adequate Roentgen-ray equipment and personnel. However, the procedure is theoretically sound, and definite progress in the performance and interpretation of "immediate" cholangiograms has been reported by Schuberth and Sjögreen, MacDonald and others.

For the past several years it has been our practice to make routine "delayed" cholangiographic examinations in all cases of common duct drainage or biliary fistula. In practically all cases there has been the satisfaction of having a visual demonstration of the common duct entirely free of stones or other obstruction. On the other hand there has been an occasional case in which the "delayed" cholangiogram demonstrated that a stone had been left behind during the common duct exploration, and a secondary operation was usually necessary for its removal. So we are convinced that digital and instrumental examination of the common bile duct is not always adequate. The various methods of using the probe, the scoop, the forceps, irrigation and suction do not always give positive proof that all stones have been removed. However, "delayed" cholangiographic study does give visual proof of the obstruction or patency of the bile ducts. And if equally as satisfactory cholangiograms could be obtained by the "immediate" method, secondary operations would be obviated and visual knowledge of the condition within the bile ducts would be obtained during the operation. This has been accomplished with a limited degree of success, but the technic of the procedure must be simplified and improved by each part of the team—the Surgeon, the Anesthetist, and the Roentgenologist—if it is to have wide acceptance and application. If given proper equipment one should, theoretically, be able to obtain visual information of the bile ducts comparable to that obtained by the Urologist in examinations of the urinary tract.

In the attainment of this objective, a number of problems and technical details are encountered. One hesitates to bring additional equipment into the operating room and add time and expense to the operation, unless results are definitely improved. In acute or extensive involvement of the gallbladder it may be difficult to inject the opaque medium into the biliary tree. The inabil-

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ity of the anesthetized patient to cooperate may cause movement on the film. Pressure or tension on the common duct or artefacts within the duct may cause misinterpretation of film.

However, we are convinced that cholangiography has great potential value as an adjunct to present day methods of gallbladder surgery. With

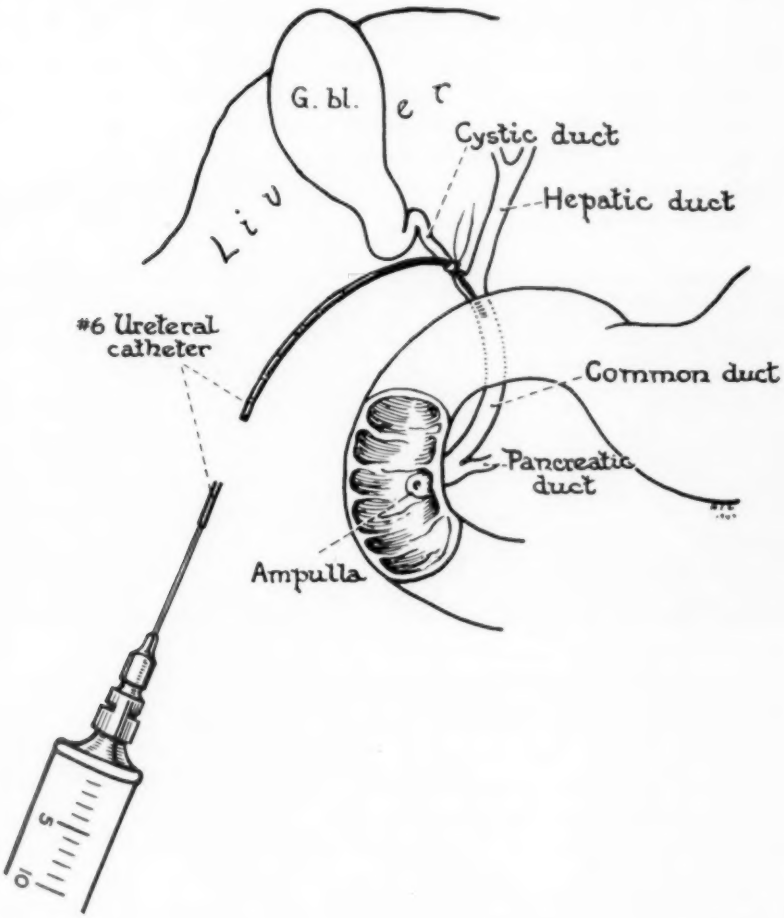


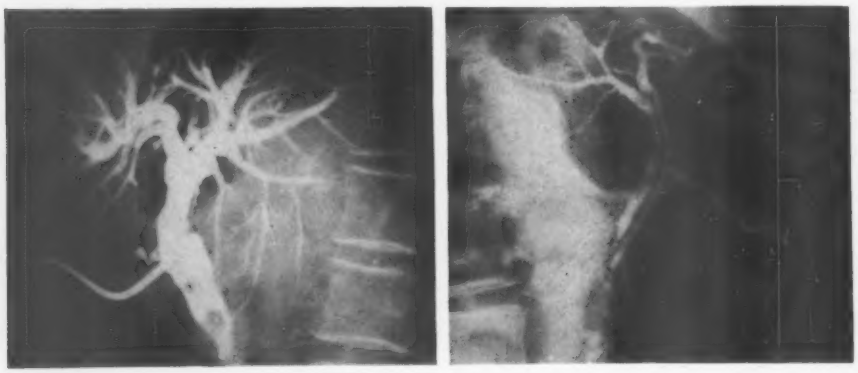
FIG. 1. Ureteral catheter passed through small incision in cystic duct for injection of opaque medium.

our present technic and the cooperative effort of the Anesthesia and Roentgen-ray Departments, we have been able to obtain "immediate" cholangiograms which have given us assurance of a normal ductal system or positive evidence of pathologic conditions in a high percentage of cases. In the cases in which we have not accomplished this result, it has usually been due to too active respiratory movement in large, thick patients; or to some minor technical error on the part of the surgical team or the roentgen-ray technic. It has

been found to give useful and desirable information in the following type of cases:

1. In common duct drainage and biliary fistula, "delayed" cholangiogram is used in all cases to determine the presence of stones or other pathologic conditions, and to observe the return of the common duct to normal size and function.

2. In acute cholecystitis, if cholecystectomy is performed, an "immediate" cholangiogram can be obtained by injecting the opaque medium through the cystic duct. If only a cholecystostomy is performed, there is no practicable advantage accomplished by an "immediate" cholangiogram; but a "delayed" cholangiogram, obtained by injecting an opaque medium through the drainage tube after free drainage has been established, will often give invaluable information.



A B

FIG. 2. A. Common duct drainage following cholecystectomy and removal of large stone from common duct. Delayed cholangiogram reveals stone in distal end of common duct. B. After secondary operation: stone removed and patent duct demonstrated.

3. In cases of elective operations for chronic cholecystitis and cholelithiasis, the "immediate" cholanigiogram can be used routinely without great difficulty or loss of time, by injecting the opaque medium through the cystic duct, the gallbladder, or the common duct.

4. In anomalies of the ductal system encountered at operation an "immediate" cholangiogram, obtained by injecting the opaque medium through the cystic duct or gallbladder, should be used and will give the surgeon assurance and comfort by furnishing immediate visual demonstration of the ductal system.

During our period of investigation we have routinely attempted, by one method or the other, to obtain cholangiograms of all gallbladder and common duct cases coming to operation. We have been encouraged by the results and convinced that greatly improved films can be obtained and our knowledge increased by simplification of the technic and improved equipment. Our series has not been sufficiently large to present convincing statistical data. We do wish to emphasize some points in technic and present a few typical cases.

SURGICAL TECHNIC

A portable Bucky Diaphragm is routinely placed on the operating table between divided pads. It is necessary that all instruments be removed from the field before the roentgen-ray exposure, so it will save time if the towels are sutured to the peritoneum instead of using towel clips. The gallbladder and ducts are examined and exposed in the usual manner. The cystic duct is well exposed, and a ligature placed around it for later typing. A small transverse incision is made into the cystic duct and a #6 uretral catheter is introduced. Its introduction will be facilitated by leaving the small wire stylet in the catheter until after it is in position and secured by the ligature around the duct. The opaque medium is injected from a 20 cc. Luer-Lok syringe through an appropriate size needle placed in the proximal end of the catheter. The use of the long ureteral catheter allows the surgeon to be entirely out of the roentgen-ray field and permits control of the rate and quantity of the injection. After the serial films are obtained, the cystic duct is completely cut across above the ureteral catheter, which is allowed to remain in place. The removal of the gallbladder is completed while the films are being developed, so that there is a minimum loss of time. If the films are satisfactory, the catheter is removed and the stump of the cystic duct is transfixed and ligated in the usual manner. If additional films are desirable, they can still be obtained at this stage of the operation.

FIG. 3. Acute Cholecystitis. Common duct slightly enlarged and induration about distal portion. Cholecystectomy: Immediate cholangiogram indicates normal and patent duct.

We have found that 35 per cent diodrast is the most satisfactory contrast medium, and have not encountered any complications in its use. Lipiodol is a very unsatisfactory contrast medium. Hippuran is also a very satisfactory contrast medium, but we have seemed to obtain better results with diodrast.

ROENTGEN-RAY TECHNIC

The roentgen-ray equipment used at the operating table consists of a Bedside unit; 110 peak K.V. and 20 M.A.

A Leisholm "wafer" grid was employed on the earlier cases, in which instances, the roentgen-ray factors were 30" distance, 20 M.A. 1.75 to 4.5

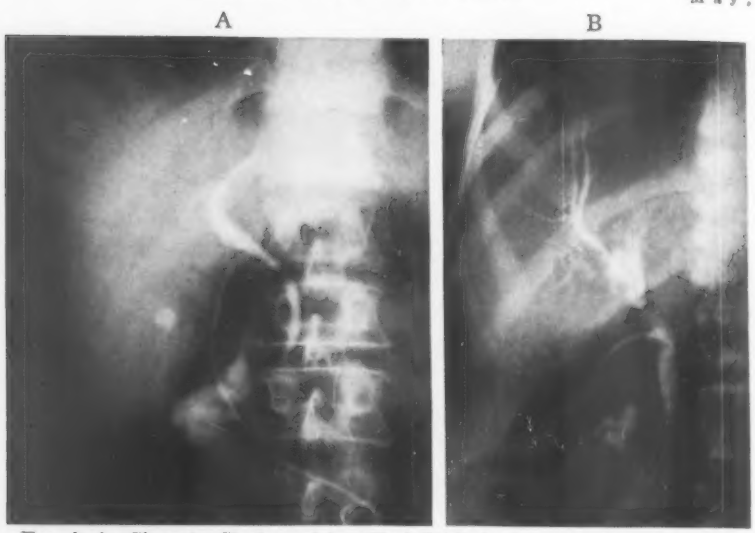


FIG. 4. A. Chronic Cholecystitis. Cholelithiasis, and Cholecystectomy. B. Examples of immediate normal cholangiograms.

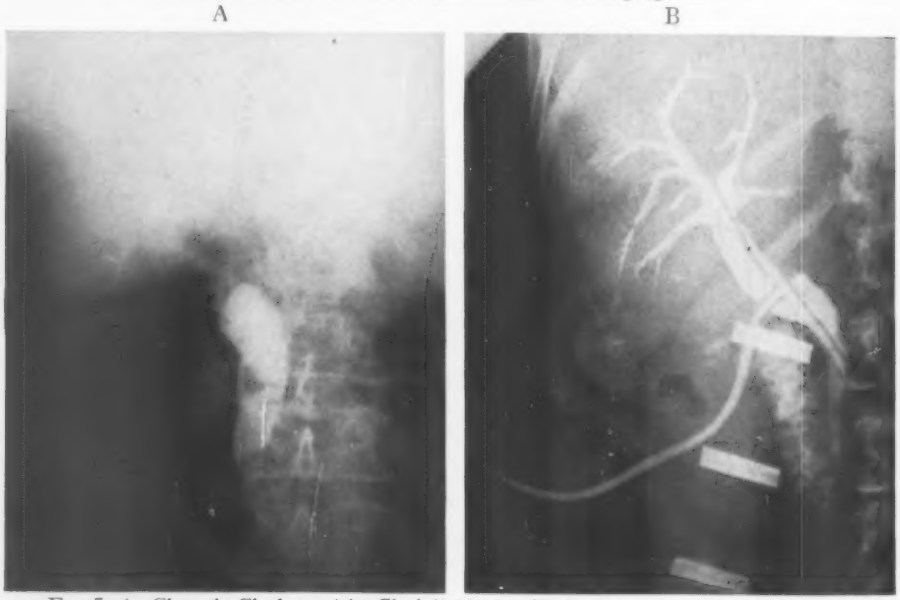


FIG. 5. A. Chronic Cholecystitis, Cholelithiasis. Cholecystectomy: Immediate cholangiogram reveals the six stones within the common duct. B. Common duct drainage same case reveals duct without obstruction.

seconds exposure. The prereading voltage was 110 K.V.; during exposure this reduces to actually 98 K.V. The time factor varies according to the thickness of the individual.

In our later cases a 36-inch 6:1 ratio Bucky was used. This has now been changed to a 30-inch 6:1 ratio Bucky, so as to employ a shorter distance and exposure time.

Film are ordinarily made following the instillation of 5 cc., 10 cc. and 15

cc. of the opaque substance. If indicated an examination is made 5 to 10 minutes later.

In postoperative cases, where a drainage tube is in place, an effort is made to empty the biliary tract simply by releasing the clamp. Exposures are then made after injection of 5 cc., 10 cc. and 15 cc. of the opaque substance, stopping immediately if the patient complains of pain in the upper abdomen or back. The examination is carried out in the anteroposterior position; occasionally stereoscopic and right lateral views are made. These have not given additional information.

The postoperative examination produces technically better films more consistently than those made at the operating table. The greatest difficulty experienced while making film during the operation has been in controlling respiration while making the roentgen-ray exposure.

CONCLUSIONS

I. Delayed Cholangiograms should have routine use in all cases of common duct drainage and biliary fistula.

II. Immediate cholangiograms are a valuable adjunct to present surgical technic.

III. Immediate roentgen-ray visualization of the common duct may be obtained in any desired case if routine preparation is made for the procedure.

IV. Better films and more accurate interpretation will be obtained when roentgen-ray units of higher amperage are available in the operating room, thus allowing shorter exposures and better control of respiration.

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ACUTE CHOLECYSTITIS*

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The frequency and surgical importance of acute cholecystitis warrant continued study and discussion of the problem. With increasing life expectancy, we can expect greater incidences of all phases of biliary tract disease. Probably no other intra-abdominal disease is handled so casually in its early stage as is this surgical emergency. Many general practitioners and internists favor the conservative treatment of the disease, recalling similar cases which have regressed with "watchful waiting." This is particularly true when patients have had previous acute episodes which subsided spontaneously. It is not appreciated that each acute attack increases the mortality by approximately two per cent. Too, they are relatively unaware of the dramatic reduction in morbidity and mortality in gall-bladder surgery during the last decade.

It is all too easy to forget that advanced acute cholecystitis is infinitely more serious than is the disease in its early stages. One of the greatest arguments against conservative therapy is that its practice by surgeons has led to widespread observation of acute cholecystitis by general practitioners and medical men. This obviously allows the disease to progress to a dangerous state in many instances before surgical treatment is sought. Only too often the initial therapy is carried out in the home where close observation is usually not feasible. Education of our fellow physicians to regard acute cholecystitis as as much of a surgical emergency as acute appendicitis would, in our opinion, reduce the present mortality and morbidity by at least one-half. The ruptured appendix (fortunately less frequently encountered now) is, usually, the result of home remedies and purgation, yet the complications of acute gallbladder disease which we see are most often due to the practice of so-called conservative therapy by physicians.

The reluctance to regard acute cholecystitis as a "surgical emergency" reminds the senior author of the slow acceptance at the turn of the century by the medical profession of early operation in acute appendicitis. It is a paradox that we are so universally agreed on the therapy of acute appendicitis and yet diverge so sharply in treatment of acute cholecystitis.

ETIOLOGY

The obvious fallacy of regarding all inflammation as due solely to bacteria resulted in the common acceptance of infection or bacterial invasion as the primary etiologic factor in acute cholecystitis. This was further substantiated by the experimental production of gallbladder inflammation by injecting streptococci into the portal circulation (Rosenow). The late Edmund Andrews was one of the earliest observers who pointed out the discrepancies

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in the infectious theory. Careful culturing of the bile and gallbladder walls in normal, chronically diseased, and acutely inflamed gallbladders revealed little difference, quantitatively or qualitatively. The failure of correlation between the presence of bacteria and the pathologic findings raised serious doubts as to the bacterial etiology of acute cholecystitis. That the primary injury may be chemical was substantiated by Mann's producing acute cholecystitis by the intravenous injection of Dakin's solution. Andrews *et al* were able to reproduce a picture clinically indistinguishable from acute cholecystitis by injecting bile salts into the gallbladder.

Womack[57] has emphasized the importance of the following factors in the pathogenesis of acute cholecystitis: (1) obstruction of cystic duct, (2) action of entrapped bile on the gallbladder wall and (3) the occasional secondary bacterial invasion, superimposed on chemically damaged tissue. This view was substantiated by experiments on dogs where obstruction of the cystic duct without removal of the gallbladder bile resulted in acute inflammation, varying in severity in direct proportion to concentration of cholesterol and bile salts. Identical cystic duct obstruction with replacement of the gallbladder bile with saline resulted in no corresponding inflammation.

COURSE

The usual initiating factor in the production of acute cholecystitis is cystic duct obstruction; this obstruction in 95 per cent of cases is due to an impacted calculus, although obstruction from congenital abnormality or inflammatory edema is occasionally encountered. Kiernan[35] reports four in a series of 102 cases of acute cholecystitis in which obstruction was not due to stones. As long as the obstruction persists, the disease is a progressive one, for the intravesical pressure increases from secretion, exudation and transudation. This increased tension may be so marked as to produce vascular interference with consequent gangrene and resultant perforation with peritoneal soiling. In 80 to 90 per cent nature will interrupt the cycle by relieving the obstruction —i.e. by dislodgement of the stone into the gallbladder or by passage into the common duct. Thus, in at least 10 to 20 per cent, surgical interference is absolutely necessary if perforation is to be avoided.

The crux of the argument of the conservative school is the ability to determine, clinically, which course of events is ensuing. Yet, the admitted lack of parallelism between the clinical findings and the underlying stage of pathology makes "watchful waiting" fraught with danger. In a revealing discourse, Touroff[53] reports 75 cases of pathologically proven acute cholecystitis, 52 of which were entirely free of clinical manifestations and 23 with only minimal signs or symptoms. Despite the paucity of clinical findings, many of the cases had empyema, gangrene and even perforation! Eliason and Stevens[16] emphasize the disparity between pathologic and laboratory-clinical findings. In 135 cases of pathologically proven acute cholecystitis, 21 per cent presented no abnormality of the leucocyte count, 23 per cent had a normal temperature and 4 per cent had no tenderness whatsoever. In any given case, accurate

determination of the exact nature and extent of the underlying stage of pathology is clinically impossible.

Proponents of watchful waiting exploit the fact that 80 to 90 per cent of acute attacks will subside at the expense of the unfortunate 10 to 20 per cent who fail to do so. Regarding acute cholecystitis as a progressive obstruction in which it is frequently impossible to determine the stage of the disease would be a much more logical plan. Certainly a disease which can disguise its acuteness so effectively should be regarded with great concern. Conservatism should be more accurately designated as "wishful waiting" instead of "watchful waiting."

TREATMENT

Review of the American literature of the past 15 years reveals an increasing skepticism of conservatism in the management of acute obstructive cholecystitis. Twenty years ago, the *rationale* of conservative treatment was not so greatly questioned. In the past decade the pendulum has swung decidedly towards early operation. Evidence has been accumulated which demands serious consideration of surgery in every case. "Clinical impression" is too inexact even in the best hands. That this is true is borne out by the frequent finding of gangrene, empyema and perforation—often without significant variations in temperature, blood count and clinical findings. Fallis and McClure[19] report an incidence of 15.9 per cent gangrene and perforation in a series of 320 cases of acute cholecystitis. Cowley and Harkins,[10] in a collected series of 2,261 cases of acute gallbladder disease, found an average incidence of perforated gallbladder of 13 per cent. The frequency of gallbladder rupture in acute cholecystitis is often obscured by writers of the conservative school who quote figures of 1 to 3 per cent which are derived by considering all cases of cholecystitis, whether acute or not. Heuer,[29] in an exhaustive study of personal cases and the literature concluded that at least 20 per cent of cases of acute cholecystitis will have the complications of gangrene, abscess or peritonitis if a policy of inactivity towards the disease is used. All agree that such complications markedly increase the seriousness of the disease—mortalities from 20 to 52.2 per cent are found in the literature. Heyd,[30] after repeated observations, states that acute cholecystitis is by no means "so benign or self-localizing a lesion as was formerly believed."

Wallace and Allen,[54] in a most comprehensive study of 415 cases of acute cholecystitis at the Massachusetts General Hospital, found gangrene present in 29.4 per cent of all cases; over half of these cases presented perforation; three had generalized peritonitis. In their series, perforation increased the mortality from 5.3 per cent to 17.2 per cent. These authors were unable to find any reliable criteria to indicate perforation and gangrene—30 of their cases suffered perforation while being observed in the hospital. Miller,[42] in 1930 at the same hospital, had emphasized that the general principle of operation on septic processes without undue delay held true for gallbladder disease. Glenn[23, 24] has been one of the foremost advocates of early operation. At the

New York Hospital, the policy has been to operate upon all patients after adequate preparation unless there is some serious contraindication which is not immediately reparable. During a 13-year-period, 527 patients have been handled in this fashion with only 13 deaths: an enviable mortality rate of only 2.4 per cent. Heyd[30] reports the lowest mortality and morbidity in those patients operated on within four days of the onset of their illness after a period of 6 to 24 hours hospitalization for preparation. Hotz [33] regards the policy of watchful waiting as a "gamble unjustified by the end results," finding 9.2 per cent of all patients operated on for acute cholecystitis to have perforation with peritonitis. His study shows only 23 per cent of these proved perforations to be definitely localized at the time of operation. Lester,[37] utilizing early operative interference, reports a mortality of less than 2 per cent in a series of 109 cases of acute cholecystitis. MacDonald[38] advocates utilization of a two-stage procedure: cholecystostomy during the acute stage and cholecystectomy as an interval procedure. He emphasizes that this is a logical plan in that it allows early relief of the obstructive element, which is rational treatment for any abdominal obstruction. He points out that decompressive procedures have well proved their worth in obstructions of the bowel.

Stone and Owings,[50] in a classic discussion given before the American Surgical Association in 1933 emphasized that it was just as logical to operate on an acute gallbladder as acute appendicitis or ruptured ulcer, although admittedly, gallbladder perforation had a much better chance of walling off. They urged early surgery, pointing out that it would result in notable saving of time, expense and danger. On the same program, Judd and Phillips[34] subscribed to the plan of early operation but urged careful individualization of all cases. Despite the decided trend towards early surgical interference, there are many who just as strongly favor delayed intervention. Pennoyer[44] believes the dangers of surgery in the acute phase are greater than the danger of the natural course of the disease. In analyzing the reports of many who statistically support the school of conservative therapy, one is struck with an obvious disparity: only the fulminating cases are subjected to early operation in their series. Then the results in the less severe cases, which are handled conservatively, are compared to the group of fulminating cases in which early surgical intervention was necessary. Obviously, such statistics are grossly misleading as they compare different stages of the disease process.

PROGNOSIS

The most important factors in the ultimate outcome are the age of the patient, duration of the acute episode, number of antecedent acute attacks and duration of chronic biliary tract disease.

That the mortality is considerably higher in the older patients has been repeatedly stressed. It is not appreciated that the elderly are more prone to develop gangrene and perforation and that early operation is especially indicated in this group. This increase in complications of acute gallbladder disease is the result of longer standing pathology with more infection in the

biliary tract and a greater degree of resultant liver damage coupled with a lessened vascular reserve, locally. Glenn[24] reports a five-fold increase in mortality after the age of 50—5.14 per cent as compared to 1.13 per cent in patients under 50. Eliason and Stevens[16] report the mortality after 60 to be 8 to 10 times the mortality prior to this age. Fallis and McClure[19] had only one death in 108 patients below 40, or a mortality of 0.9 per cent, but had five deaths in 48 patients 60 and above, with a mortality of 10.5 per cent.

The factor of duration of symptoms is of the utmost importance, for complications—gangrene, pericholecystic abscess and peritonitis—are more frequent after the first 72 hours. Delay increases the chances of obstructive jaundice and allows for prolonged liver damage. All agree that these complications are conducive to increased mortality and morbidity. One cannot help but be impressed with the technical feasibility of operation and smooth convalescence following removal of an acute gallbladder in the early stage of the disease.

RESULTS OF QUESTIONNAIRE

Realizing the subject of acute cholecystitis to be a controversial one, aid was sought from the various members of the Southern Surgical Association. A gratifying questionnaire response was obtained, for 151 of the group doing general surgery reported. Although admittedly difficult to answer such questions briefly, the following results were obtained:

Question I.—In acute cholecystitis, do you favor early or delayed operation? Of the 151 general surgeons queried, 101, or 66.8 per cent, favored early operation, while 38, or 25.1 per cent, preferred delayed surgical intervention. Twelve members, or 8 per cent, did not associate themselves with either group, pointing out that individualization of cases decided the issue.

Abell[1] remarks that he has "long been an advocate of early operation in acute cholecystitis; this position resulted in watching several patients go from bad to worse in subsequent gallbladder gangrene, perforation, sub- and intrahepatic abscess and pancreatitis." Stone[51] emphasizes that he is a "strong believer of prompt operation in this condition." Boland[5] states that he has "never regretted operating on an acute gallbladder." Royster[47] points out that early operation worked so well when he was a recent patient with acute cholecystitis, that he now, more than ever, is an advocate of early intervention. Anglem, Carter, Cole, Estes, Finney, Gage, Goode, Longmire, C. W. Mayo, Ochsner, Rankin and Rienhoff are among those favoring early definitive surgery in acute cholecystitis.

Womack[58] and the Barnes Hospital group withhold surgery in most instances of acute cholecystitis unless there is evidence of progression rather than subsidence of the disease. McClure[39] urges conservative treatment and emphasizes the importance of following prothrombin studies and liver function tests carefully. Dinsmore[12] believes the dangers of delayed operation have been over-emphasized. Rives[46] prefers delayed or interval surgery unless the sever-

ity of the process does not permit. Other advocates of "watchful waiting" include Curtis, David, Guthrie, King and Venable.

Although it is clearly evident that this controversial problem has not been settled, there has been in the last fifteen years an unquestionable trend toward early (though not immediate) intervention.

Question II.—In general, is cholecystectomy or cholecystostomy your procedure of choice?

If technically feasible and the patient is in reasonably good condition, cholecystectomy was overwhelmingly favored as the procedure of choice. Only 4 of 151 practice routine or usual cholecystostomy; 3 of this 4 are proponents of delayed surgical intervention. Drainage only is practiced by most of the group in the very elderly and extremely ill patients and when the local pathology is so advanced as to make identification of vital structures difficult. Many advocate cholecystostomy in severe diabetics. The method of partial cholecystectomy first suggested by Denegre Martin is not infrequently used in the severe cases. Heyd[32] favors cholecystectomy by a similar technic: division of the gallbladder from the fundus to the cystic duct with complete enucleation of the mucosa. The incision is then sutured and a rubber tube introduced. He classifies the immediate result as a cholecystostomy; the ultimate result is obliteration of the gallbladder. Penick[43] advocated early cholecystectomy but advises cholecystostomy if operation must be done between 72 hours and ten days. Rankin[45] also favors removal of the gallbladder but states, "I am not ashamed to do cholecystostomy and believe I have saved many lives with this procedure." Mahon[40] is content to do gallbladder drainage *in selected cases* "without embarrassment or apology." Cholecystostomy is usually accepted as a compromise, but life-saving procedure. There is little doubt that it produces a clinical cure in a small, but appreciable, percentage of cases. Especially is this true in those patients in whom there is a single large stone impacted in the cystic duct with minimal damage to the gallbladder wall. Donald[13] finds -ostomy curative in a large per cent of gangrenous gallbladders and utilizes it frequently in patients of increased risk.

Question III.—Do you advise concomitant choledochostomy?

Agreement was again manifest in the answers to this question, for the usual response was—"rarely," "not routinely by any means" and "only when definitely indicated." The majority explore the duct only when jaundice is present, palpable stones are evident, the duct is thickened and unquestionably dilated, and in the presence of a moderate to marked associated pancreatitis. Some few routinely aspirate the common duct and explore it when abnormal bile is obtained. A smaller group advises choledochostomy when small calculi are present within the gallbladder. As most cases of true acute cholecystitis are secondary to cystic duct obstruction, there is usually not associated disease of the common duct. Allen[2] believes choledochostomy indicated in less than 10 per cent of acute cases. Goode,[25] however, utilizes choledochal exploration in approximately 30 per cent of his cases. Gatch,[22] on the other hand, believes

opening the common duct in the presence of acute cholecystitis is often dangerous.

Question IV.—Do you recognize a critical period in which surgery seems contraindicated?

Unfortunately this question was a bit too ambiguous and some declined to generalize about it. However, the following critical periods were emphasized:

(1) Period of dehydration and electrolyte imbalance. Although many were strong proponents of early operation, all were even more emphatic opponents of immediate operation. The importance of adequate preoperative reparation in which fluid, chemical and protein balance are restored was repeatedly emphasized. Such preparation can usually be accomplished in a few hours (usually 6 to 12).

(2) From 72 hours to 7 to 10 days after onset of acute attack. The dangers of this period were forcefully emphasized by many. The technical difficulties at operation were notoriously greater during this period. Allen[2] states, "The mortality was higher in our cases when the operation was undertaken between the 4th and 12th days after attack began. We, therefore, wait, if one can, until the attack subsides entirely unless we can get the patient in condition for surgery before the fourth day of disease." This view was supported by Burch, Gardner, Mixter, Ochsner, Owings, Penick and others.

(3) Definitely subsiding acute cholecystitis when first seen. Balfour, Churchill and Mayo stress the dangers of surgery in this period.

The beforementioned periods are the usual critical times recognized. All are not in full accord, however. Frank Glenn[25] admits the technical difficulties of late acute or subacute cholecystic disease, but advises early surgery in view of "The unpredictable course." Profound ante-mortem collapse is essentially the only critical period recognized by Stone.[51]

SUMMARY

Significant lowering of the still appreciable mortality in acute cholecystitis would be obtained by:

(a) More widespread "prophylactic" biliary tract surgery. We are heartily in accord with the concept that there is no such thing as a "silent or harmless gallstone." As the future course is so unpredictable, all are to be regarded as potentially dangerous. This is especially true in the older age group where acute cholecystitis is such a severe disease. Such interval cholecystectomies should be done with a risk of less than one per cent. It is not unlikely that this risk is actually less than the danger of malignancy in a calculous gallbladder.[20]

Although the Graham-Cole test has been one of the greatest advances in the management of gallbladder disease, too much emphasis is placed on actual visualization of positive or negative gallstone shadows. If intrinsic liver disease is reasonably excluded and the test properly done on several occasions with consistent failure of visualization of the gallbladder, surgery should be strongly

considered in all cases, as above 90 per cent of such cases will have biliary calculi.

(b) Regarding biliary colic and acute cholecystitis as "surgical emergencies." This does not imply that such cases are to be operated on as quickly as appendicitis or ruptured ulcer. A period of preoperative preparation of four to eight hours is essential to restore electrolyte and fluid balance and carefully evaluate the patient. During this period the diagnosis can be definitely established. Early surgery is then indicated; this will obviate the gamble, which we consider unnecessary and definitely hazardous, of attempting to determine the course of a frequently progressive disease by clinico-laboratory methods. That a policy of diligent observation is an unsound one is accepted universally in acute appendicitis but is, unfortunately, a controversial one in acute cholecystitis. It is likely that 75 per cent of episodes of acute appendicitis will subside without primary operation, but no surgeon will sanction such treatment. Is it not a paradox that some of these same surgeons will observe the progress of acute cholecystitis on the basis that 80 to 90 per cent will subside?

General acceptance of early surgery as the treatment of choice in the acute gallbladder will obviously do away with the procrastination and casualness so frequently encountered in the early stage of the disease. Instituting operative therapy before the period of complications—empyema, gangrene and perforation—will, needless to say, dramatically reduce the morbidity and mortality of the disease.

Cholecystectomy will be feasible in above 90 per cent of the cases and is, without a doubt, the procedure of choice in trained hands. However, there will always be cases in which the general condition of the patient is sufficiently precarious or the local pathology so marked that identification of the vital structures is not feasible; this group should be handled by cholecystostomy. In severely ill patients, this may be a life-saving procedure and can be executed under local anesthesia practically without risk.

(c) Careful individualization of cases in the beforementioned critical periods:

(1) When first seen. Parenteral fluids, nasogastric suction, sedation and, frequently, blood should be used. While early operation is ideal treatment, immediate surgery is often unjustified and dangerous.

(2) From the 3rd or 4th day to the 10th day after onset of the disease. This period is commonly recognized as having the highest morbidity and mortality. It is the period of advanced disease—the time of systemic depletion, impaired hepatic function and local complications; pericholecystic abscess and peritonitis. It is the period to be avoided by instituting early surgery. Careful individualization is essential. In contrast to the first 72 to 96 hours in which all cases should be considered seriously for early surgery, this period should be approached with a more conservative attitude. If the disease fails to subside or becomes progressive, then surgery is indicated. In this state of

advanced disease, cholecystostomy is often the procedure of choice and should be done without apology. It is infinitely better to do a safe drainage procedure than a heroic extirpation. Such advanced acute cholecystitis is the result of neglect, procrastination and "wishful waiting" and should best be treated by avoidance—i.e., early definitive surgery.

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DISCUSSION.—DR. WILLARD H. PARSONS, Vicksburg, Miss.: It seems to me that the very informative paper of Doctor Barksdale and Doctor Johnston poses, among other possibilities, two important considerations: First, should patients having acute cholecystitis be subjected to immediate surgical intervention, should they be treated conservatively so long as their condition continues to improve or, finally failing to improve, should they be subjected to exploration?

The essayists, in agreement with the many distinguished surgeons whom they quote, believe that patients having acute cholecystitis should be operated upon during the early phase of the disease. The truth of the matter is that I do not, and I rather doubt that many of those present encounter a great number of patients having acute cholecystitis within the first 24 or 48 hours of its onset. Perhaps education of general practitioners and of our medical colleagues will alter this situation. Unless and until it does, surgeons will not have the opportunity of treating a great many patients for acute cholecystitis sooner than the second or third day of illness. The authors quote Allen as stating that surgery is particularly hazardous between the fourth and twelfth days after the attack begins. They further state that Allen advises waiting, if one can, until the attack subsides entirely unless the patient can be operated upon before the fourth day of the attack. This seems to me sound practice and has been the course I have elected to pursue.

The second question of concern presented by the essayists is the matter of whether or not patients having acute cholecystitis are apt to have stones in the common duct and, if stones are present, what should be done about them. Everyone of experience agrees that the common duct should not be explored unless all the vital structures in that area can be identified. For that matter, no operation on the biliary tract other than cholecystostomy ought to be done unless this is possible, and it is usually failure to do so that leads to disaster. I had hoped the essayists would precisely record their personal experience in this matter, for Doctor Barksdale and I practice in adjacent communities and would perhaps expect to encounter about the same types of lesions in our practice.

Of the last 100 consecutive patients on whom I have personally operated for disease of the biliary tract, 15 had acute cholecystitis clinically and pathologically. Of this group one or two had gangrene of the gallbladder with perforation. In 14 of the 15 patients, the gallbladder was removed, in one it was drained for various reasons and, a few weeks later, stones were removed from the common duct and the gallbladder was removed. Seven of the 15 patients, or slightly less than 50 per cent, had stones removed from the common duct at the time of the primary operation.

In other words, during this particular period of time, 15 per cent of the patients on my service having surgery of the biliary tract, had acute cholecystitis. Of those having acute cholecystitis, essentially all had a stone, or stones, in the cystic duct and 50 per cent

had stones in the common duct. Of this group of 15 patients referred to, fortunately none died.

Reducing the affair to a practical basis, it would seem to me desirable to educate general practitioners and internists to the necessity of promptly requesting surgical consultation for patients having acute cholecystitis. It would further seem proper if one encounters, during the early phase of the disease, a patient with acute cholecystitis, to remove the gallbladder and do such other procedures as might be prudent and indicated. The majority of patients having acute cholecystitis are not encountered early in the course of the disease and these patients, I believe, ought to be treated conservatively, provided their condition improves, until after the critical phase of the disease has passed. They may then be subjected to appropriate surgery with increased safety.

Dr. Hubert A. Royster, Raleigh, N. C.: I was very grateful to Doctor Barksdale for including me in his questionnaire. I thought I might answer his questions best, if I appeared in person as a witness and as Exhibit A. Since the last meeting of this Association I have been through all the stages of the disease that Doctor Barksdale has described. Many years ago I was imbued with the idea that acute inflammation of the gallbladder should receive immediate surgical attention. But I was very timid about it and I presented a short paper on "Should We Operate on the Acutely Inflamed Gallbladder?" I was impressed by this because, when you got a patient who had been through the acute period, after four or five days operation was easy; the gallbladder could be peeled out like a banana from its skin. On the other hand, appendicitis and cholecystitis in the acute forms are not wholly analagous, because in the former rupture and gangrene are very frequent. But I still think these conditions in the gallbladder are rare.

I was seized with intense pain which let up in about a week; at the end of that time I was operated on, the surgeon finding acute empyema of the gallbladder with intense edema throughout the biliary tract (as I understand it; I did not have a mirror)—intense edema, which is a serious complication. The surgeon drained my gallbladder and after a long siege of drainage of pure bile, the gallbladder was subsequently removed. In addition, of course, they tied my superficial femoral veins and also had me practice, in my own way, early ambulation. I had already stuck out my neck about that, so I had to practice what I preached.

In addition, six months later, I still have some pain at 5:00 A.M. and 5:00 P.M. I used to wonder why my patients had that, and now I understand. I expressed to Doctor Barksdale the procedure which I think we should adopt: Cholecystectomy, if you can, cholecystostomy, if you must. In surgery there is many an "if-and-but"; also an occasional "and/or" and often a "whether-or-not"; which reminds me of the preacher who gave out notices at the Sunday morning service. Said he: "On Wednesday night there will be the usual prayer meeting, God being willing. On Friday afternoon there will be the annual Sunday School picnic at 3:00, whether or not."

Dr. Malcolm Thompson, Louisville, Ky.: The limitations of time prevent, I regret, my discussing more than one of these excellent papers, so my remarks will be confined to the subject of gangrenous cholecystitis. As Doctor Barksdale has told us, gangrenous cholecystitis is a serious condition requiring surgical operation early in its course.

In operating upon a patient with gangrenous cholecystitis the surgeon is motivated by two desires. The first is to remove all the necrotic tissue which, if permitted to remain, will act as a focus for the continuation of peritonitis. The second is to avoid opening new avenues of infection, biliary contamination, and hemorrhage, while removing the diseased tissue.

Although classical cholecystectomy will remove all the diseased tissue, it opens up new planes for infection and may lead to hemorrhage from the hepatic bed in a patient poorly prepared for such loss of blood or added injury. Although drainage alone will not promote spread of the infection nor lead to undue hemorrhage, it does not afford removal

of all the diseased tissue, nor will it ensure against a recurrence of the disorder should the patient survive. In addition, cholecystostomy alone is often inadequate because if the gangrenous process has not already involved the entire gallbladder it may do so later.

Doctor Barksdale has mentioned Doctor Martin's contribution. In 1922, at the Memphis meeting of this Association, Dr. E. D. Martin of New Orleans described for the relief of gangrene of the gallbladder what he called a compromise between complete excision and drainage, in which he opened the gallbladder to the cystic duct and removed the mucosa by the use of curettage and escharotics. This was followed by drainage of the remaining portion. This method of Doctor Martin's avoided the undesirable features of cholecystectomy while retaining the feature of removal of the diseased portion and left, upon recovery, a harmless fibrous cord. Subsequently, Doctors Gatch, Estes, Heyd, and Pribram reported similar methods.

After hearing Doctor Martin, Doctor Abell modified the procedure somewhat and has used it since when the occasion presented. As now performed, that portion of the gangrenous gallbladder which is not intimately attached to the liver is excised with a sharp instrument to the origin of the cystic duct. Bleeding points, which are usually only one or two, are ligated individually with a suture type ligature. That portion of the mucosa remaining upon the hepatic attachment of the gallbladder is removed from its bed by sharp dissection. The fibromuscular coat remains upon the liver and from it receives enough blood to survive. The operation is completed by insertion of a soft drain to the orifice of the cystic duct which, in my experience, has not been involved in the gangrenous process as it receives collateral circulation from the vessels in the duodenohepatic ligament.

Those of us who have profited in countless ways from Doctor Abell's teaching and example can assure you that this is a most satisfactory procedure and is, I believe, the one of choice for treating gangrenous gallbladders. Those of you who have yet to perform it for the first time will be pleased, as I was, at the ease and rapidity with which it can be done, the relatively small amount of bleeding, the smooth convalescence provided there is no serious complication, and the permanence of relief.

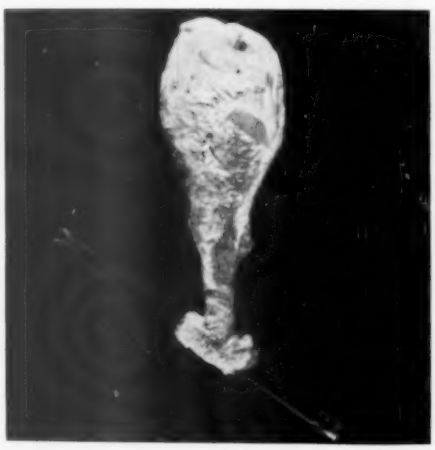

FIG. 1.

FIG. 2.

FIGS. 1 and 2.—Slides demonstrating findings.

DR. CHARLES M. EDELEN, Louisville, Ky.: I have enjoyed the papers of Doctors Hagan and Barksdale. It has been my pleasure to have assisted Doctor Hagan on many of his cases. In the method just described he has materially reduced the usual delay incidental to obtaining a direct cholangiogram during the surgical procedure.

Only recently an occasion arose in which I was greatly relieved by the cholangiographic findings. In the course of a simple retrograde cholecystectomy I encountered an anomalous cystic or aberrant duct. At first glance I thought I had tented and removed a segment of the common duct. Further exploration, however, fortunately for the patient and myself, proved this not to be the case. An immediate cholangiogram gave additional confirmative evidence for which I was most grateful.

The two slides I would like to show demonstrate our findings. (Figs. 1 and 2, Page 827.)

DR. J. W. BARKSDALE, Jackson, Miss. (closing): I regret that I have not the figure in percentages of calculi in the common duct. In some desperately ill and aged patients where the time factor was a desideratum greatly to be desired, no attempt was made to discover the presence of stones. Realizing that in this class of cases life hangs by an exceedingly tenuous thread the effort has been made to compromise by doing the least possible surgery. It has been thought better in some instances, should it become imperative, to postpone to a later date operation on the common duct.

In reading the paper, time did not permit dwelling *in extenso* on the Martin method of cholecystectomy. In many instances it has obvious advantages and is often a life-saving procedure. By carefully attempting to evaluate each individual case and to follow such procedure as might be indicated in a particular case, we have had no deaths in our gallbladder surgery in the last 318 cases.

DR. J. HARVEY JOHNSTON, Jackson, Miss. (closing): While serving as residents at Charity Hospital in New Orleans, Dr. R. B. Brunazzi and I studied with Dr. Alton Ochsner the records of all patients with clinically and pathologically proven acute cholecystitis for the five-year period prior to January, 1946. This hospital is unique in actually being three hospitals in one. Although the medical and clinical facilities are identical, each service is an independent one with its own policy of practice. An excellent opportunity for a controlled comparison of results in acute cholecystitis was offered, for one service favored early operation and another practiced delayed intervention.

The study comprised 140 cases of unquestionable acute cholecystitis both from a clinical and pathologic standpoint; 54 per cent were treated by early operation, 46 per cent by observation with operation only when the disease failed to regress. In analyzing the clinical picture it is important to note that 25 per cent failed to present leukocytosis and only 30 per cent had admission temperatures exceeding 100.4 degrees, while 95 per cent presented pain and tenderness. Palpable mass was found in 40 per cent. Thus, I believe it is a mistake to wait for the development of fever, leukocystosis, and palpable mass before making a clinical diagnosis of acute cholecystitis.

More advanced pathology was found at operation in the delayed operation group; 22.5 per cent empyema as contrasted to 10.5 per cent in the early operation series; rupture with localized peritonitis in 6.5 per cent as compared to 3.9 per cent. Although I have heard several outstanding men say they have never seen a case of generalized peritonitis as a result of acute gallbladder disease, there were five cases in this series of 140, an incidence of 3.6 per cent! Associated adenocarcinoma of the gallbladder was found in two, or 1.4 per cent.

Morbidity studies showed that hospitalization averaged 30.5 days in the delayed group and 19.5 days in the early operation cases. In those cases hospitalized within three days

of the onset of acute illness, mortality was 6.7 per cent in those cases submitted to early operation and 12.5 per cent in the patients treated expectantly. However, in the patients hospitalized more than 72 hours after the beginning of their illness, 18 per cent died if submitted to early operation, while 9 per cent expired when delayed surgery was practiced. Although the series is small, it is evident that early cholecystectomy is the procedure of choice in the first 72 to 96 hours of the illness. If operation is neglected during this period, it would seem much wiser to defer operation, if at all possible, from the fourth to the seventh day of the disease, as early surgery in this period had a prohibitive mortality.

The beforementioned mortality figures are higher than those usually encountered. This is due partly to the type of patient treated, but mainly to the rigid criteria each case fulfilled before being classed as acute cholecystitis. As we were earnestly trying to evaluate the conflicting types of therapy, all borderline cases were excluded.

A CLINICAL EVALUATION OF CHERNEY'S INCISION*

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IN THIS COUNTRY, the usual surgical approach to the pelvic viscera is through a median suprapubic or paramedian incision. Our preference has been for the paramedian incision and usually the exposure has been adequate. However, many situations are encountered in which the operation could be facilitated by more exposure. This is because most of the structures in the depth of the pelvic cavity run perpendicular to the axis of the vertical incision and are located near its lower angle where retraction is limited by the attachment of the recti to the pubis. For these reasons, many continental surgeons have favored the Maylard or Bardenheuer incision.

This incision begins one to two fingerbreadths below and medial to the antero-superior spine and proceeds in a gentle curvilinear fashion to a point one or two fingerbreadths below and medial to the opposite antero-superior spine. All layers of the abdomen are divided in the plane of the incision. Exposure is facilitated as the transverse diameter of the lower abdomen is 25 per cent greater than the distance from the umbilicus to the symphysis. Since exposure is a function of the length of the incision, the transverse incision gives a field one and one-half to two times greater than the usual vertical one. It may be argued that lengthening the vertical incision will produce the same exposure. This, however, is not true as regards exposure of organs within the true pelvis, as exposure is limited by the bony framework of the pelvic inlet. Here again the greater transverse diameter of the true pelvis produces the same result of an increase of one and one-half to two times the exposure. In addition to the greatly increased exposure, the transverse incision is more efficiently used as the course of most structures is parallel to the axis of the incision, and in line with the eye of the operator.

The disadvantages of the Bardenheuer type of incision result from the anatomic features peculiar to the subumbilical region. When the rectus muscle is divided above the level of the tendon and below the entrance of the 11th and 12th thoracic nerves, the lower or pubic segment of the divided rectus is denervated. The absence of tendinous inscriptions in the subumbilical region allows the rectus to contract and separate the cut ends more widely than in the supra-umbilical region. Perhaps the weakest point of the incision is the absence of a well developed posterior rectus sheath at the level of the incision. At the time of closure of such an incision, the abdominal wall consists solely of the sutured peritoneum and the fascia of the anterior sheath. It is, therefore, definitely not as strong as a sutured rectus cutting incision in the upper abdomen. These anatomic disadvantages can readily be seen to favor the inci-

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Tuesday, December 9, 1947.

dence of postoperative hernia and evisceration, although many observers state that this is not unduly high.

In spite of its disadvantages, the continental surgeons have found the Bardenheuer incision useful and indicated in certain cases. With few excep-

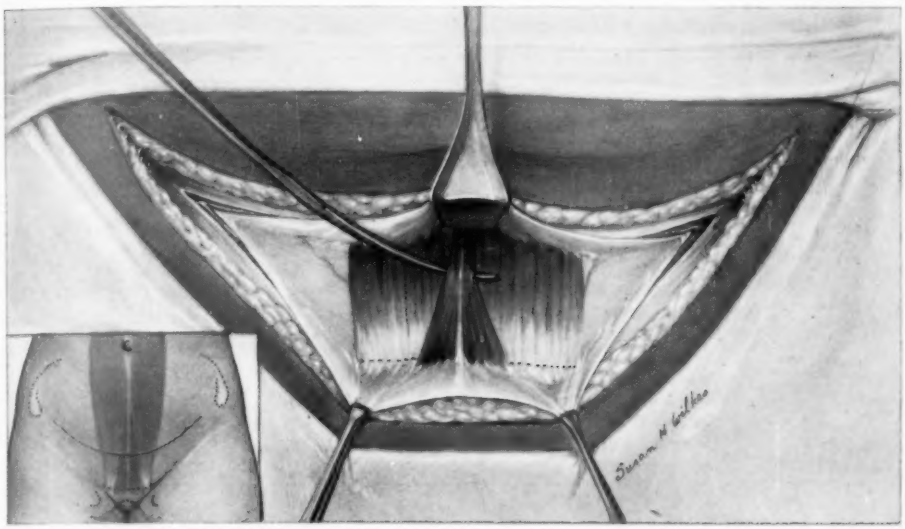


FIG. 1.—Lines of division of pyramidales and rectus tendons.

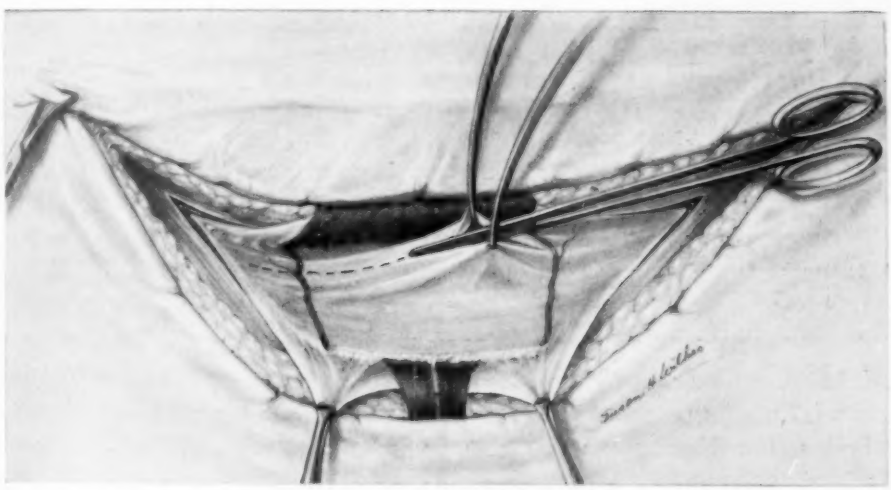


FIG. 2.—Transverse incision of peritoneum.

tions[4] most American surgeons know of it by name only. This is probably due to the fact the Europeans have used it primarily for the radical operation for carcinoma of the cervix, and this operation has until recently been of infrequent occurrence among us. A more radical attitude toward the problems of uterine malignancy and the tendency to resections and anastomosis in the

lower sigmoid and upper rectum have contributed to a desire for better than average exposure in the depths of the true pelvis. This need has expressed itself in a search for an improved transverse lower abdominal incision.

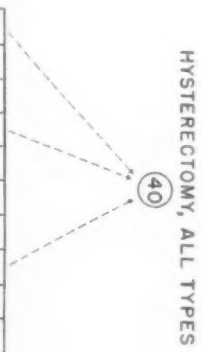
Cherney[1, 2] presented a modification of Bardenheuer's incision which does much to overcome the anatomical disadvantages. This incision has been used by Fallis[3] to advantage in resection of the rectum and by Smith[5] for exposure

TABLE I

Diagnosis	Number	Per Cent
Fibromyoma Uteri	29	48.3
Endometriosis	7	11.6
Ovarian Tumor	4	6.66
Carcinoma of Cervix	3	5.0
Cephalo-Pelvic Disproportion	3	5.0
Ovarian Failure	3	5.0
Carcinoma of Fundus	2	3.33
Carcinoma of Sigmoid	2	3.33
Diverticulitis and Diverticulosis	1	1.66
Gangrene of Ileum	1	1.66
Intussusception	1	1.66
Stricture of Ileum (X-Ray)	1	1.66
Peritoneal Inclusion Cyst	1	1.66
Ureteral Calculus	1	1.66
Retroversion	1	1.66

TABLE II

OPERATION	NO.	%
HYSTERECTOMY, COMPLETE	35	58.3
OOPHORECTOMY	4	6.66
MYOMECTOMY	4	6.66
HYSTERECTOMY, RADICAL (WERTHEIN)	3	5.0
CESARIAN SECTION	3	5.0
RESECTION SIGMOID	3	5.0
RESECTION SMALL INTESTINE	3	5.0
HYSTERECTOMY, SUBTOTAL	2	3.33
URETEROLITHOTOMY	1	1.66
EXCISION PERITONEAL CYST	1	1.66
SUSPENSION (OLSHAUSEN)	1	1.66



of the lower ureter. Petit[4] found it difficult to close. In spite of these opinions, there is little factual material in the literature based on any substantial number of cases. For this reason, it has seemed wise to us to call attention again to the incision and to present an analysis of 60 cases in which it has been used.

DESCRIPTION

The skin incision is made in a curvilinear fashion beginning from one to two fingerbreadths below and medial to the antero-superior iliac spine, crossing the midline, running almost straight and just within the hairline, and terminating below the iliac spine of the opposite side (Fig. 1). It is carried through the subcutaneous tissue down to the aponeuroses of the external oblique

muscle and the anterior rectus sheath. At either end of the incision the superficial epigastric vein is usually encountered, divided and ligated.

The anterior sheath of the rectus muscle is incised in the line of the skin and the incision is extended laterally through the aponeuroses of the external and internal oblique muscles, thus exposing the underlying recti with the transversalis fascia and peritoneum laterally. In the more central portion, the aponeuroses of the obliques are fused, but as the incision is extended laterally, two separate layers are recognized at the ends of the wound. The fleshy

TABLE III—*Morbidity*

Days	0	1	2	3	4	5	6
Number	19	13	12	12	2	0	2
Per Cent	31.7	21.6	20.0	20.0	3.3	0	3.3

Total Morbidity = 93 Days
Average Morbidity = 1.55 days
In this Study morbidity includes any day in which temperature exceeded 38°C(100.4°F) including day of operation.

TABLE IV

Ambulatory	No.	Per Cent
First Day	49	81.6
Second Day	8	13.3
Third Day	2	3.33
Later (6th Day)	1	1.66

TABLE V

Complication	Number	Per Cent		
Cystitis	3	5.00	Wound Infection	None
Atelectasis, Minimal	3	5.00	Thrombo Phlebitis	None
Diarrhea	2	3.33	Pulmonary Embolism	None
Pre Vesical Hematoma	1	1.66	Wound Disruption	None
Total	9	15.00		

fibers of the internal oblique muscle come into view under the aponeurosis of the external oblique. In exceptional cases the internal oblique muscle may be encountered more medially and may be split if necessary. The lower flap of the rectus sheath is grasped on either side of the midline and separated from the underlying recti by sharp dissection down to the pubic bones. The pyramidalis muscles are then dissected from the recti and the tendinous insertions of the recti are divided close to the pubic bones, allowing the recti to be reflected upward.

The peritoneal cavity is entered laterally and the incision is carried across one to two fingerbreadths above the reflection of the bladder peritoneum. The peritoneal incision usually extends from one inferior epigastric artery to the other. There is no contraindication to dividing one or both arteries (Fig. 2).

In closing, the peritoneum is sutured with interrupted sutures of #40 cotton. Curarization is a distinct aid in overcoming any difficulty in the closure.

The tendinous ends of the recti are reapproximated with interrupted sutures. It is much easier to place all these sutures before tying. The lateral ends come together easily. The method of tying is quite simple. The assistant approximates the tissues with the next to the end suture while the operator ties the end suture. This allows a knot to be set without tension as the strain is taken by the untied approximated suture more medially.

The pyramidalis muscles are then allowed to fall into place. The anterior rectus sheaths and the aponeuroses of the oblique muscles are then closed in one layer, care being taken to pick up both layers in the lateral portions of the wound. The subcutaneous tissue and the skin are sutured in the usual manner.

There were 60 cases in which this incision was used (Tables I and II). They represented a wide variety of pelvic lesions. Two-thirds of the cases were gynecologic. In these, a superior exposure was afforded by the incision. However, this wide exposure is not necessary for the usual gynecologic procedures. In the more difficult cases, the incision is a distinct advantage. Three of our cases had carcinoma of the cervix and were submitted to radical hysterectomies. These, as well as the one case of ureteral calculus in the lower ureter, illustrated the desirability of the incision for exposing the ureter in its terminal portion. In low cervical and extraperitoneal Cesarean section, the exposure of the lower uterine segment is accomplished more easily than in the customary vertical incision. There were two cases of carcinoma in the recto-sigmoid and one case of diverticulitis in the same region. All these were subjected to resection and anastomosis and all anastomoses were at or below the peritoneal reflection. Under ordinary conditions we have found this can be a trying procedure, but in these cases the anastomoses were easily done.

The convalescence of this diversified group of cases was remarkably smooth in spite of the fact that many were submitted to radical and extensive procedures.

In calculating morbidity, a day of morbidity was defined as any day in which the temperature exceeded 38°C (100.4°F), including the day of operation (Table III). In the entire series there was a total of 93 days of morbidity with an average morbidity of 1.55 days.

The patients in this series were allowed to walk as soon as their condition permitted. Of these, 81.6 per cent were walking on the first postoperative day and all except one were up and walking by the third day (Table IV).

There were no deaths and remarkably few complications (Table V). There were no wound infections. All wounds were securely healed and in satisfactory condition on the patient's discharge from the hospital. Unless otherwise indicated this occurred on the ninth postoperative day. All except six cases have been observed at periods ranging from one to ten months, and in no instance has wound weakness or herniation been noted. The recti were apparently intact in all. Three patients complained of some residual soreness in the lateral angles four months after operation. It was not unusual to see some

cutaneous hypesthesia within the arc of the incision. The single complication relative to the wound was the development of a prevesical hematoma which satisfactorily resolved. There were no cases of thrombophlebitis or pulmonary embolism in this small group.

SUMMARY

The Cherney incision offers marked advantages for the execution of difficult surgery deep in the pelvis. The wounds heal satisfactorily if properly closed. It is recommended as a distinct advance in those cases presenting problems of exposure.

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DISCUSSION.—DR. JOE V. MEIGS, Boston: I rather hoped I would not have to discuss this paper. I have the greatest respect in the world for Doctor Burch and for this incision. We have tried a transverse incision cutting straight through the fascia and recti muscles. It is very easy to do and a perfect incision to operate through. After 150 cases I finally discovered a number of hernias. I have given it up, but my associate, Doctor Parsons, still considers it satisfactory.

The Cherney incision of which Doctor Burch speaks, cuts across the insertions of the recti into the pubes. We have used it and discarded it. For operations on the bladder or the lower end of the ureter it is perfect. We have done about 150 radical operations for cancer of the cervix, and in no instance have we had any difficulty in approaching the area of operation through the midline incision. It gives by far the best approach. I thoroughly agree that so far as convalescence is concerned the transverse incision is better. In young girls in whom we do not want to leave a scar the hairline Pfannenstiel incision is very satisfactory. No muscles are cut across and one can get plenty of room to do most pelvic surgery, including hysterectomy. For radical surgery I believe the midline incision is best.

DR. JOHN C. BURCH, Nashville, Tenn. (closing): I think in fairness it should be stated that the incision Doctor Meigs used is the Bardenheuer incision, and not the incision described. So far we have had no hernias; maybe we will get them. Certainly we have had them with the vertical incision. As to exposure, that is a matter of opinion. I am no stranger to the problems involved in radical surgery in the pelvis. In my opinion this incision, for my use in my way, has a distinct advantage. The reason for that is simple. When one is doing a radical operation or must operate deeply in the pelvis the structures at the bottom of the pelvis are in line with the eye, and it is not necessary to pull against the recti to get exposure. I grant it is more difficult to make and to close. It may have a higher incidence of hernias, but so far we have had none. When success of the operation depends on exposure, it deserves serious consideration.

"WET LUNG"—AN EXPERIMENTAL STUDY*†

I. The Effects of Trauma and Hypoxia

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"WET LUNG" or "traumatic wet lung" are terms used to denote the accumulation of fluid in the lungs following accidental or operative trauma. This fluid may consist of blood, transudates, exudates or mucous in any combination. The term "pulmonary edema" is often used loosely to describe this picture. Edema in the strict sense implies an increase in interstitial fluid. However, as it has been applied to the lungs, it indicates the accumulation of pulmonary transudates within the air passages.

"Wet lungs" often are primary obstacles to recovery. Their treatment was of particular concern during the recent World conflict.[1, 2, 3] The mechanism by which "wet lung" is produced is poorly understood. In these studies we have reproduced "traumatic wet lung" experimentally. The resultant changes have been studied.

I. THE PRODUCTION OF EXPERIMENTAL WET LUNG

Methods—Twenty-one mongrel dogs were anesthetized with intravenous sodium pentobarbital in doses of 30 milligram per kilogram of body weight.

Trauma to the chest wall was produced in the anesthetized animal in two ways. Trauma was produced to the right hemothorax in all experiments. In all experiments the animal was fully anesthetized. In 14 experiments in this group a falling weight was used. In seven additional animals the right chest was shot in a tangential direction with a .45 calibre pistol as was described in a previous article.[4] The degree of trauma, established at autopsy, has been judged on two bases: First, the damage sustained by the thoracic cage; second, the damage sustained by the lungs. Four grades have been established and are used throughout this paper:

1. *Very slight.*—no ribs broken—Pleura intact—Minimal hemorrhage into the adjacent lung without lacerations.

2. *Slight.*—Simple fractures of one or two ribs—Pleura intact. Shallow lacerations of the lung, if any, with slight adjacent hemorrhage.

3. *Moderate.*—Complete fractures of one or two ribs. Slight to moderate pleural tears. Lacerations of the lung often present. Hemorrhage involving approximately one-half of the directly traumatized lobe and often involving

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Equipment in the Lung Station of the Department of Medicine, a laboratory organized under a Grant from the Commonwealth Fund, was used in a part of this research.

adjacent lobes. Occasionally slight hemorrhage posteriorly in the opposite (left) lung.

4. *Severe.*—One, two, sometimes three ribs shattered—Large pleural defects. The directly traumatized lobe completely hemorrhagic, often to the extent that it assumed the consistency of the liver, and usually lacerated. Adjacent lobes considerably involved with hemorrhage. Hemorrhage posteriorly in the opposite (left) lung.

In 13 of the experiments arterial blood samples were drawn from the right femoral artery for the determination of arterial oxygen saturation and the hematocrit. Portions of nine were kept refrigerated under oil until the determination of oxygen saturation was made. This was never more than five hours after the sample was obtained. A portion of each sample was placed in an ammonium oxalate bottle for the determination of the hematocrit. The first sample was obtained after anesthesia was induced, the second 15 to 20 minutes after the animal had been traumatized. The third and final sample was drawn just before termination of the experiment. The only exception is in the case of animal 58 (see Table I); in this instance the third sample was obtained at 24 hours.

Arterial oxygen saturations were determined according to the method of Van Slyke and Neill.[5] The hematocrits were determined in Wintrobe hematocrit tubes.

The animals remained on dog boards in the anesthetized state throughout the short-term experiments. In the experiments which were continued for 24 to 72 hours the animals were allowed free movement and access to food and water after reacting.

All animals which did not die as the result of trauma were sacrificed with large intravenous doses of sodium pentobarbital sufficient to produce almost instantaneous death. In the early experiments the lungs were removed at autopsy with clamps on each hilus. Each lobe was individually tied off, cut free, and weighed. These weights were expressed in terms of per cent of body weight. These ratios were found to correlate well with the amount of fluid present in the bronchi, observed at autopsy. The practice of weighing each lobe was, therefore, soon discontinued.

The amount of fluid present has been graded for each lobe on the basis of the amount exuding from the cut ends of the bronchi with gentle pressure. These observations are recorded in Table I as follows:

1. Very slight
2. Slight
3. Moderate
4. Considerable to excessive

The figures recorded in Table I are the approximate averages for all lobes of both lungs.

The abdomen was opened at autopsy in all experiments to determine the extent of intra-abdominal injuries.

TABLE I.—*The Production of Wet Lung by Trauma*

Animal No.	Agent Used to Produce Trauma	Time Interval Between Trauma and Termination of the Expt.	Cause of Death	Degree of Trauma	Amount of Pulmonary Fluid	Arterial Oxygen Saturation (Vol's %)			Hematocrit (packed cell volume)		
						1	2	3	1	2	3
13	Weight	15 Minutes	Trauma	3+	2.5+						
14	Weight	26 Hours	Sacrificed	3+	2.5+						
15	Bullet	26 Hours	Sacrificed	3+	2.5+						
16	Bullet	20 Minutes	Trauma	3+	2.5+						
17	Bullet	28 Hours	Sacrificed	2+	1.5+						
18	Weight	27 Hours	Sacrificed	2+	1.0+	.....	.....	.....	46	40	46
19	Weight	15 Minutes	Trauma	3+	2.0+						
20	Weight	4 Hours	Sacrificed	4+	3.0+	9.09	7.01	8.81	33	29	33
21	Weight	4½ Hours	Sacrificed	2+	1.5+	.....	.....	.....	43	40	48
22	Weight	4½ Hours	Sacrificed	3+	2.0+	13.12	11.12	15.45	38	38	40
23	Weight	4½ Hours	Sacrificed	3+	2.5+	.....	.....	.....	44	48	41
26	Weight	5½ Hours	Sacrificed	4+	3.0+	13.23	6.23	10.00	41	37	35
27	Bullet	4½ Hours	Sacrificed	1+	0.5+	12.12	10.73	12.00	34	31	33
28	Bullet	4½ Hours	Sacrificed	4+	3.0+	9.81	4.53	9.15	30	29	25
29	Bullet	4½ Hours	Sacrificed	4+	3.0+	15.24	10.08	11.44	40	35	34
30	Bullet	5 Hours	Sacrificed	1+	1.0+	6.17	6.82	8.46	22	22	24
55	Weight	4 Minutes	Sacrificed	2+	1.5+						
56	Weight	4 Minutes	Sacrificed	1+	1.0+						
57	Weight	24 Hours	Sacrificed	2+	2.0+	.....	.....	.....	42	42	42
58	Weight	72 Hours	Sacrificed	3+	0.5+	11.47	5.16	11.94	38	39	36
112	Weight	4½ Hours	Sacrificed	1+	0.5+	11.01	11.28	11.16	37	38	37

Results.—Table I shows the results of the 21 experiments in this series. The type of injury and the subsequent pathological picture were so similar with the two methods used in producing thoracic trauma that they are considered together without distinction.

Examination of Table I reveals the following facts:

1. Traumatic wet lung was produced routinely with the methods employed.

2. The amount of pulmonary fluid produced in each experiment varied directly with the degree of trauma.

3. The pulmonary fluid appeared very rapidly after theracic trauma, was still present in proportion to the trauma inflicted at 24 hours, and had largely disappeared at 72 hours.

The microscopic pathologic picture of traumatic wet lung as it was produced in these experiments is as follows:

1. Alveolar rupture with extravasation of blood into the air spaces as previously described by one of the authors (R.A.D.)[4] and compared by him to blast effects obtained experimentally in water[6] and air.[7, 8, 9]

2. The presence of edema fluid characterized microscopically by dilated extravascular and lymphatic spaces and the presence of this fluid within the alveoli and bronchioles.

Grossly there was hemorrhagic consolidation of the directly traumatized lobes varying from slight to the consistency of liver. Often there was hemorrhage in the posterior portion of the opposite (left) lung, especially in the more severely injured animals. Frothy blood-tinged fluid exuded from the cut ends of the bronchi with gentle pressure. It was often present in the trachea. It was present in the greatest amounts in those lobes containing the most hemorrhage. The direct impact was usually over the lower lobes. Consequently, they were ordinarily the most severely involved. However, lobes exhibiting no gross evidence of trauma usually contained fluid, frequently in considerable amounts. The distribution of fluid in those areas of both lungs which did not appear to be traumatized was patchy and irregular, however.

Bleeding into the pleural cavity occurred in a few animals in small amounts. Three animals died of hemorrhage from lacerated wounds of the liver (Nos. 13, 16, 19.) Small hepatic lacerations were observed frequently.

Table I reveals that arterial oxygen saturation in animals which received severe trauma, sustained a drop which was out of proportion to the fall in hematocrit. A subsequent rise was then noted, even in the face of large accumulations of pulmonary fluid. There was little change in the oxygen saturation following slight trauma. The changes in the hematocrit were irregular. There was an initial drop in seven of 12 experiments. This was followed by a return to the pre-experiment level or above in three of the seven. There was a persistent depression in the remaining four, in all of which severe trauma had been inflicted.

II. THE EFFECT OF INFUSION OF ISOTONIC SODIUM CHLORIDE ON THE "TRAUMATIC WET LUNG"

Methods.—Eighteen mongrel dogs were anesthetized with intravenous sodium pentobarbital in doses of 30 milligrams per kilogram of body weight.

This series of experiments is divided into two groups:

In 11 experiments trauma was produced with the falling weight as in Series I. The average degree of trauma was, however, less than in Series I (Table II). Intravenous infusions of isotonic sodium chloride solution were then begun. They were administered from an infusion flask of one liter through rubber tubing and a glass cannula tied in the left femoral vein. The fluid was at room temperature in all experiments. The amounts of saline infused and the rates of infusion were varied. In experiments 59 and 60 small infusions were given before trauma was produced.

Seven animals were administered infusions of sodium chloride in exactly the same manner but were not subjected to trauma.

In nine of this series of experiments arterial blood samples were obtained for the determination of the arterial oxygen saturation and the hematocrit. The first sample was drawn after anesthesia was induced, the second sample shortly before termination of the infusion.

Venous pressure was recorded continuously in ten of the experiments. The measurements were made with a U-tube mercury manometer connected throughout the experiment into the right femoral vein, through rubber tubing, a 2 cc syringe and an 18-gauge needle. The fluid used in the system was isotonic sodium chloride.

The arterial blood pressure and the pulse were recorded in eight of the experiments. The blood pressure was obtained at intervals throughout the experiment from the exposed right femoral artery with a 20-gauge needle and U-tube mercury manometer. The pulse was obtained at intervals by direct count from the right femoral artery. Only the initial and the final values are recorded in Table II.

The animals were sacrificed with large intravenous doses of sodium pentobarbital with the exception of those expiring as a result of the infusions (Experiments 47 and 48). At autopsy the amount of pulmonary fluid and the degree of trauma inflicted were recorded as described for Series I. The degree of damage sustained by the liver, as determined by the extent of lacerations and the amount of blood lost into the abdominal cavity, was graded on the basis of 1, 2 or 3 and recorded in Table II because of the significant bearing it has on the results of this series of experiments.

Results.—The results of this series of experiments are tabulated in Table II. The difficulty with which pulmonary edema may be produced in experimental animals by intravenous infusions[10, 11, 12] is apparent in the control series of seven experiments. Isotonic sodium chloride injected intravenously at a rate of 10 cc per kilogram of body weight per minute to a total of 558.8 cc. per kilogram produced only very slight evidence of pulmonary edema. This

is the equivalent of a little over 33 liters in 56 minutes for an average man (60 kilograms).

The infusion of the smaller amounts of isotonic saline resulted in an increase in the pulmonary fluid in six of 11 traumatized animals. There was in addition a difference in the distribution of the fluid as compared with traumatized animals receiving no infusions (Series I). It was found to be distributed uniformly throughout both lungs, whereas, in Series I there was a patchy distribution of fluid with localization of the severest grades of edema in the directly traumatized lobes.

The quantitative differences in the amount of pulmonary fluid in Series I and in the traumatized animals in Series II are not adequately described by figures. Comparable thoracic trauma resulted in small amounts of pulmonary fluid in Series I. Intravenous infusions of isotonic saline in amounts and at rates of injection which routinely are associated with no edema in normal animals produced diffuse collections of pulmonary fluid in six of the 11 traumatized animals of Series II. It was present in such amounts that it exuded from the cut ends of the bronchi for a matter of minutes with only the intrinsic pressure of the lung. These lungs tended to maintain their expanded shapes with a jelly-like consistency. In the remaining five experiments smaller amounts of pulmonary fluid were found at autopsy for reasons given in detail below.

The accumulation of fluid was less marked in three animals of this series which received severe thoracic trauma (Nos. 52, 59, 87). Two of these animals (52 and 59) sustained lacerations of the liver which allowed considerable quantities of blood to escape into the abdominal cavity. Another (animal 87) sustained a severe laceration of the right upper lobe which extended through its entire thickness with the escape of considerable quantities of blood into both pleural cavities. Luisada[14] has commented on the prevention of pulmonary edema by simultaneous bleeding in animals receiving rapid intracarotid infusions. Two other animals (89 and 114) sustained very slight thoracic trauma. Their lungs also contained very little fluid. The extent of pulmonary edema which followed saline infusion was therefore proportional to the extent of trauma to the lungs.

The changes in the peripheral vascular dynamics and the hematocrit which we have noted in these experiments have been essentially the same as those dscribed by other investigators studying intravenous infusions.[10, 11, 16, 17, 18, 19] The arterial blood pressure increased initially then steadily declined to below pre-infusion levels. The pulse was uniformly fast following pentobarbital anesthesia and showed an inconstant rise with infusion. The venous pressure rose steadily. Hemodilution occurred routinely.

The venous pressures, the arterial blood pressures, the pulse rates and the hematocrits for the two groups are not significantly different. The final values for arterial oxygen saturation relative to the hematocrit are somewhat lower

TABLE II.—*The Effects of Venous Infusions of Isotonic Saline Upon the Normal and the Traumatized Lung*

Animal No.	Rate of Infusion cc/kg/Min.	Amount of Fluid Infused per Kilo. Body Wt.	Cause of Death	Degree of Liver Damage	Degree of Trauma	Amount of Pulmonary Fluid	Venous Pressure Mm. Hg.	Arterial Blood Pressure		Pulse Rate		Arterial Oxygen Saturation (Vol's %)		Hematocrit (packed cell volume)	
								1	2	1	2	1	2	1	2
47	4.9	102.1	Expt.	...	...	0	4—24								
48	10	558.8	Expt.	...	...	1.5+	4—56	...	...	...	..	14.34	4.44	37	18
61	6.9	212.7	Sac.	...	...	0	0—16	...	...	...	...	15.35	10.06	39	25
62	11.4	250	Sac.	...	...	0	2—28	...	...	...	...	14.69	7.42	44	20
85	9.5	304.3	Sac.	...	...	0	....	142	148	137	137				
88	9.6	308.1	Sac.	...	...	0	....	170	128	160	124				
94	10.6	337.6	Sac.	...	...	1.0+	....	154	130	190	170				
51	7.3	300.7	Sac.	0	2+	4.0+	2—16	...	...	...	...	15.12	8.66	40	24
52	6.1	141.4	Sac.	3+	2+	1.0+	2—10	...	...	...	...	18.53	7.91	48	23
53	7.6	229	Sac.	0	3+	4.0+	2—20	...	...	...	...	19.65	9.86	46	27
54	8.1	138	Sac.	0	2+	4.0+	2—20	...	...	...	...	15.28	5.58	46	26
59	11	131.6	Sac.	2+	2+	1.5+	0—10—0	...	...	...	...	.....	.....	44	39
60	12.5	125	Sac.	0	2+	3.0+	2—12—2	...	...	...	...	8.80	4.47	28	27
87	11.5	241	Sac.	0	4+	2.5+	....	128	80	160	164				
89	10	200	Sac.	0	1+	2.0+	....	106	98	160	176				
93	7.6	228.3	Sac.	0	2+	4.0+	....	122	108	124	256				
113	6.5	225.3	Sac.	0	2+	4.0+	....	144	132	186	150				
11	46.6	198.4	Sac.	0	1+	0.5+	....	140	152	148	170				

in the traumatized animals than the control group. This can be explained on the basis of the increase in pulmonary fluid in the traumatized group.

The hearts of the animals in these experiments were found to be slightly but uniformly dilated. This has been noted by other observers studying massive infusions.[13, 18] An exception occurred in the instance of experiment 47 in which the animal expired after receiving a relatively small amount of saline. This animal's heart was markedly dilated and there was no pulmonary edema.

Diarrhea occasionally occurred during the course of the infusions. Buccal and nasal secretions often became excessive. At autopsy all hollow abdominal organs were distended with fluid. Ascites was present in varying amounts. These findings are essentially as described in other observations on intravenous infusions.[10, 18]

III. The effect of anoxia on the "Traumatic Wet Lung"

Methods.—Seventeen mongrel dogs were anesthetized slowly with intravenous sodium pentobarbital in doses sufficient to produce only the lighter planes of anesthesia.

The animals were connected to a continuous spirometer circuit by means of a tight fitting rubber mask with an inflated cuff. A 100-liter bell spirometer served as the reservoir. Mercury-seal valves were used in the circuit. A soda-lime cannister removed carbon dioxide. All connections were of rubber tubing of large size.

The amount of oxygen in the inspired air was lowered initially by mixing nitrogen with room air in the spirometer. In five experiments the per cent of oxygen was kept at approximately a constant level by slowly adding tank oxygen to the spirometer air. Single average values for the per cent of oxygen are recorded in those experiments (Table III). In the remaining 12 experiments no attempt was made to replace the oxygen utilized by the animal. Two values are recorded for the per cent of oxygen. These represent the initial and final values.

Determinations of oxygen in the mixtures were made on 10 cc samples of gas withdrawn from the circuit through small rubber tubing. The determinations were made in a small modified Haldane apparatus. Oxygen was removed from the samples by repeated contact with pyrogallol over a wide surface area. The values reported represent the average of several samples. Repeated tests on room air revealed the accuracy of the method to be within a fraction of one per cent.

Arterial blood samples were obtained for the determination of arterial oxygen saturation and hematocrit in six experiments of this group. The first sample was drawn after anesthesia was induced, the second sample during the course of the experiment as indicated in Table III.

In addition to the procedures outlined above, eight of the animals were given infusions of isotonic sodium chloride solution through the left femoral vein. The rates of infusion and the amounts of saline administered are

recorded in Table III. The venous pressure was recorded continuously in five of the eight experiments by means of a mercury manometer connected to the right femoral vein. The initial figure recorded in Table III refers to the venous pressure before the experimental procedure was begun. The second figure indicates the venous pressure shortly before the death of the animals.

All of the 17 experiments in this series resulted in the death of the animals At autopsy the thoracic and the abdominal organs were examined.

Results.—The data from this series of experiments are tabulated in Table III. Intravenous infusions of isotonic sodium chloride decreased the survival time of eight hypoxic animals by more than 50 per cent as compared with the nine hypoxic animals receiving no fluid.

At autopsy the lungs of those animals expiring as the result of hypoxia alone were moderately congested in appearance, but exhibited no pulmonary fluid. The hearts were of normal size. On the other hand, the lungs of five of the eight animals expiring as the result of hypoxia plus intravenous infusions exhibited severe congestion and large amounts of fluid. The appearance of these lungs was comparable to that described in Series II for traumatized animals receiving intravenous infusions. Moderate cardiac dilatation was present.

The average per cent of oxygen in the inspired air was 13.1 per cent for those animals receiving infusions as compared to 11.4 per cent for those which received none. The average rates of infusion and total amounts of fluid injected per kilogram are considerably below those for control animals of Series II (Table II) which received infusions but breathed room air.

In three experiments the animals died after relatively small infusions of saline (experiments 36, 37 and 41). At autopsy there was considerable cardiac dilatation, but no pulmonary fluid. This picture in animals receiving intravenous infusions has been noted previously.

Examination of the values for arterial oxygen saturation reveals little difference between the two groups in this series of experiments, in spite of the large amounts of fluid observed in the lungs of five of the eight hypoxic animals receiving infusions. Determinations of the pressure changes in the rubber mask during respiration revealed changes no greater than one centimeter of water. Increasing dyspnea terminating in respiratory failure was noted in nearly all of these experiments. The changes in the venous pressure and the hematocrit in these experiments were similar to those observed with infusions in Series II.

DISCUSSION

"Traumatic wet lung" has been reproduced experimentally in mongrel dogs by both blunt trauma and tangential bullet wounds of the thoracic cage (Table I). The pathologic picture has been found to consist of:

1. The extravasation of blood in the lung.
2. The transudation of fluid into the interstitial spaces and the alveoli and bronchi.

TABLE III.—*The Effects of Hypoxia and of Intravenous Saline Infusions Upon the Lung*

Animal	Per cent Oxygen in Inspired Air.	Rate of Infusion cc/Kg./min.	Amount of Fluid Infused per Kilo. Body Wt.	Survival Time in Minutes	Amount of Pulmonary Fluid	Venous Pressure mm. Hg.	Arterial Oxygen Saturation (Vol's %)		Hematocrit (packed cell volume)		Point in Expt. at Which Blood Sample No. 2 was Obtained
							1	2	1	2	
30	12	....	....	150	0	....					
31	11—7	....	....	90	0						
32	10—7	....	....	60	0						
33	11	....	....	390	0						
34	12	....	....	180	0						
35	17—12	....	....	150	0						
38	14—10	....	....	120	0						
49	16—8	....	....	90	0	....	11.74	3.71	....	....	55 Minutes
50	16—8	....	....	135	0	....	11.20	3.75	....	....	55 Minutes
36	11	....	70	....	0						
37	13	5.	75	40	0						
39	14—2	8.7	348.5	50	4.0+						
41	14—12	2.0	20.1	25	0	8—14					
42	14—12	2.9	86	45	3.0+	8—20	13.84	2.67	37	34	44 Minutes In Extremis
44	14—10	3.3	148.5	60	4.0+	2—24	12.33	3.50	45	40	35 Minutes Venous Pr. 14
45	16—15	7.3	110	15	4.0+	4—24	11.59	0.80	33	26	12 Minutes In Extremis
46	16—14	6.7	280.5	55	4.0+	0—34	10.79	5.08	41	24	31 Minutes Venous Pr. 16

The greatest degrees of pulmonary wetness were found in the areas of greatest hemorrhage in the traumatized lungs. However, fluid was often present in significant amounts in grossly untraumatized areas of the lungs. The total amount of fluid in the air passages varied directly with the degree of trauma inflicted.

Intravenous infusions of isotonic sodium chloride in amounts and at rates of injection which have little effect on the lungs of normal animals intensified the "wetness" of the slightly traumatized lung (Table II). Generalized pulmonary edema resulted. The difficulty with which pulmonary edema may be produced by intravenous infusions in the normal animal[10, 11, 12] has been substantiated in our control experiments (Table II).

Drinker[20, 21] has stressed the role of anoxia in the development of pulmonary edema. Asphyxia is known to result in a marked increase in capillary permeability.[22] We have demonstrated pulmonary edema in hypoxic animals receiving infusions of isotonic sodium chloride (Table III). It was comparable to that observed in traumatized animals receiving similar infusions. Wet lungs could not be produced by the breathing of low concentrations of oxygen alone, however.

There is the possibility that severe grades of anoxia may exist in hemorrhagic areas of the traumatized lung on the basis of the blocking of air passages with blood and serum. Examination of the changes in arterial oxygen saturation in Series I reveals, however, that after an initial depression the saturation increased, even in the face of considerable "pulmonary wetness". Similarly, in Series II the depressions in arterial oxygen saturation were of approximately the same magnitude for the control animals with no pulmonary edema and the experimental animals with severe edema. Therefore, we feel that anoxia will not suffice to explain the wetness in grossly untraumatized areas of the lung following thoracic trauma.

There is an alternative explanation for the occurrence of pulmonary edema in areas of pulmonary hemorrhage. Harper and Tait[1] have called attention to the irritating effects of dispersed blood on the pulmonary tissue with the resulting transudation, and secretion of fluid. This cannot explain the formation of edema fluid, however, in those areas of the lungs in which no evidence of trauma was found.

Inspiratory resistance[23, 14] and dyspnea[21] are known to contribute to the formation of pulmonary transudates. Neither was present to a significant extent in our experiments on traumatized animals. On the other hand, increasing dyspnea occurred in all the experiments on hypoxic animals and may have played a part in the development of pulmonary edema following the infusion of saline.

There are changes which result from intravenous infusions which are important factors in pulmonary transudation. The pulmonary venous pressure has been found to increase.[10, 17, 18] It has been said to rise more rapidly and to greater heights than the peripheral venous pressure.[18] The increased peri-

pheral venous pressure which developed in our experiments would indicate considerably elevated pressures within the pulmonary veins. Hemodilution occurs routinely[10, 16, 11, 19] as reflected in decreasing hematocrits in our experiments. These changes undoubtedly contributed to the intensification of the pulmonary edema which we observed in traumatized and hypoxic animals receiving infusions of isotonic saline. They are, however, similar for both the control and the experimental animals.

The occurrence of generalized wet lung following localized pulmonary trauma cannot be completely explained on the basis of the data obtained in the experiments reported in this paper.

SUMMARY

1. "Traumatic wet lung" has been produced experimentally in mongrel dogs by blunt trauma and tangential bullet wounds of the thoracic cage.

2. Infusions of isotonic sodium chloride in amounts which have little effect on the lungs of normal animals have been found to intensify the pulmonary wetness which follows experimental thoracic trauma.

3. "Wet lung" has also been produced in dogs breathing low concentrations of oxygen by the infusion of isotonic sodium chloride solution but was not produced by hypoxia alone.

4. Studies of the arterial oxygen saturations, hematocrits, peripheral venous pressures, peripheral arterial blood pressures and the pulse rates in these experiments have not revealed variations of enough significance to explain the occurrence of generalized wet lung associated with localized areas of pulmonary injury.

II. Neurogenic Factor

William R. Cate, Jr., M.D., and Rollin A. Daniel, Jr., M.D.

In Part I. of this paper we described the experimental production of traumatic wet lung in dogs. Intravenous infusions of isotonic sodium chloride solution were found to intensify the pulmonary wetness which follows thoracic trauma. The result was a generalized collection of pulmonary fluid. The outpouring of fluid was just as intense in areas of the lung fields in which there was no demonstrable evidence of pulmonary damage as in the lobes in which there was gross evidence of trauma. We were unable to explain these findings on the basis of the data which we had obtained.

The cause of acute pulmonary edema has been the subject of controversy for many years. Welch[41] believed that left ventricular failure causes the syndrome. There is a considerable body of literature concerning the occurrence clinically of pulmonary edema accompanying disturbances in the central nervous system.[24, 25] This picture, in the absence of heart disease, has not been satisfactorily explained. It has been suggested, by numerous observers, that pulmonary edema is dependent in certain instances upon reflex changes affecting the pulmonary vessels. Recently Luisada[14, 27] and Farber[19, 26, 28] have arrived at this conclusion as the result of animal experimentation. The latter

believes that the pulmonary edema which occurs in the rabbit and guinea pig following bilateral cervical vagotomy is similar to that which occurs in man following lesions of the central nervous system. He believes it is produced by an alteration in the vasomotor control of the pulmonary vessels, and terms the syndrome "neuropathic pulmonary edema."

More recently, Reichsman[23] has reviewed the subject of pulmonary edema which follows bilateral cervical vagotomy in experimental animals and has performed a large number of well controlled experiments upon rats. He concludes that the important factor in the pulmonary edema produced in this manner is inspiratory obstruction.

Luisada and Sarnoff[14] performed unilateral stellate ganglionectomy upon three dogs and bilateral stellate ganglionectomy upon one dog. They believed that this procedure offered some protection against pulmonary edema produced by the rapid intracartoid infusion of large amounts of isotonic saline solution.

Henneman[29] has recently reviewed the literature on the subject of acute pulmonary edema.

We have conducted a number of experiments designed to determine the effect of unilateral and bilateral stellate ganglionectomy and dorsal sympathectomy upon experimental wet lung, particularly as produced by trauma and the intravenous infusion of saline.

METHODS

Mongrel dogs of various weights and undetermined ages were used in all experiments. All animals were anesthetized with sodium pentobarbital, 30 milligrams per kilogram of body weight, administered intravenously.

Two methods of producing "wet lung" were used:

1. Thoracic trauma, produced by a falling weight, followed by the intravenous infusion of isotonic sodium chloride solution as was described in our previous paper.

2. Bilateral cervical vagotomy followed by the intravenous infusion of isotonic saline as was described by Farber in the rabbit.[19]

Sympathectomy was performed in all animals under aseptic conditions. An antero-lateral incision was made through the second, third or fourth intercostal space. The stellate ganglion and the second, third and fourth thoracic ganglia were removed intact with the chain. The lung was reinflated and the wound of the chest wall was closed in layers with interrupted fine silk sutures. 50,000 units of penicillin in solution were placed in the pleural cavity of most of these animals before closure of the wound. In the early experiments in which bilateral sympathectomy was performed, the operation was carried out in stages, five to seven days elapsing between operations. In the later experiments bilateral sympathectomy was performed in a single operation through separate incisions.

In most of the experiments a period of one week or more elapsed between

the time of sympathectomy and the experimental procedure. This was thought to be desirable in order to eliminate factors caused by operative trauma and altered pulmonary dynamics which might predispose to pulmonary edema.

At autopsy light adhesions between the superior lobes and the line of incision in the parietal pleura were found in some animals. In most animals no adhesions or fluid were present and there was no other evidence of previous pulmonary damage.

All unilateral sympathectomies were performed on the right side. The term "dorsal sympathectomy" will be used throughout this paper to indicate the operation described.

The arterial blood pressure was obtained at intervals throughout all experiments from the exposed right femoral artery, with a U-tube mercury manometer and a 20-gauge needle. The fluid used in the system was isotonic saline. The pulse rate was also recorded at frequent intervals throughout the experiments.

All infusions consisted of isotonic sodium chloride solution administered through glass canulae into the femoral vein.

RESULTS

In our previous paper we called attention to the association in a few animals of cardio-vascular failure during infusion with the absence of pulmonary edema. We have omitted the experiments of this paper in which such an association was noted. They comprise ten or 16.7 per cent of the total.

Five of 11 animals with bilateral dorsal sympathectomy expired during infusion (45.4 per cent). Only two of 12 animals with unilateral dorsal sympathectomy succumbed (16.7 per cent). The greater mortality rate among the dogs with bilateral sympathectomy may have been caused by postoperative debilitation of the animals.

A. The Effects of Trauma and of Infusion of Isotonic Saline Upon the Lungs of Animals Previously Subjected to Dorsal Sympathectomy.

Nine dogs in which previous dorsal sympathectomy had been performed were subjected to blunt thoracic trauma followed, within ten minutes, by intravenous infusions of isotonic sodium chloride solution. The results are recorded in Table I.

In five animals sympathectomy was bilateral and in four unilateral. The longest time interval between operation and the experimental procedure was 21 days, the shortest seven days.

Only one animal in the entire group of nine developed diffuse pulmonary edema. Bilateral sympathectomy had been performed seven days prior to the experiment (Dog No. 228b).

These results are to be compared with the collection of large amounts of pulmonary fluid in six of 11 animals similarly treated but without the benefit of a dorsal sympathectomy (Series II of our previous paper). The difference is even more apparent when we recall that three of the five animals of the latter group not developing excessive amounts of pulmonary fluid had

TABLE I.—*The Effect of Dorsal Sympathectomy Upon Wet Lung Produced by Trauma and Intravenous Saline Infusions*

Animal No.	Dorsal Sympathectomy	Time Between Sympathectomy and the Expt.	Degree of Trauma	Rate of Infusion cc/kg/min.	Amount of Saline Infused per Kg. Body Wt.	Cause of Death	Amount of Pulmonary Fluid	Arterial Blood Pressure Mm. Hg.*		Pulse Rate	
								1	2	1	2
228	Bilateral	17 Days	3+	8.0	252.6	Sac.	1+	104	84	102	98
106	Bilateral	7 Days	2+	6.5	254.2	Sac.	0.5+	106	86	126	126
228b	Bilateral	7 Days	4+	13.4	227.3	Died during infus.	4+	124	76	116	110
3c	Bilateral	9 Days	3+	17.9	268	Sac.	1+	126	120	144	78
106b	Unilateral	12 Days	3+	8.3	266	Sac.	0.5+	128	112	112	112
1c	Unilateral	21 Days	3+	6.9	254.2	Sac.	1+	120	102	126	130
5b	Unilateral	8 Days	2+	9.3	277.8	Sac.	0.5+	124	130	136	200
3b	Bilateral	12 Days	4+	9.0	266.7	Sac.	1+	120	106	170	176
303	Unilateral	7 Days	3+	7.5	240.9	Sac.	1+	104	102	112	128

* Reading No. 1 was taken just before the experimental procedure (trauma) was started.
Reading No. 2 was taken just before the death of the animal.

TABLE II.—*The Occurrence of Wet Lung in the Dog Following Bilateral Cervical Vagotomy and Intravenous Saline Infusions*

Animal No.	Time Between Vagotomy and Infusion	Rate of Infusion cc/kg/Min.	Amount of Saline Infused Per Kg. Body Weight	Cause of Death	Amount of Pulmonary Fluid	Arterial Blood Pressure* Mm. Hg.		Pulse Rate*	
						1	2	1	2
73	0	8.9	257.1	Sacrificed	2+	134	90	160	136
74	11 Minutes	6.9	255.2	Sacrificed	0	156	140	149	112
75	33 Minutes	8.1	251.7	Sacrificed	4+	140	120	170	141
76	39 Minutes	11.4	250.0	Sacrificed	4+	148	90	145	125
77	47 Minutes	11.1	222.2	Sacrificed	4+	156	84	165	120
84	35 Minutes	8.9	160.6	Sacrificed	4+	164	114	180	120
91	38 Minutes	7.7	230.8	Sacrificed	4+	136	128	190	168
115	5 Minutes	6.2	272.2	Sacrificed	0				
116	25 Minutes	7.2	103.7	Sacrificed	4+				
117	26 Minutes	6.6	277.1	Sacrificed	4+				
118	16 Minutes	6.5	333.3	Sacrificed	0				
119	18 Minutes	6.4	268.0	Sacrificed	4+	150	124	170	126
120	26 Minutes	7.0	266.7	Sacrificed	0	132	132	152	144
121	51 Minutes	6.1	257.8	Sacrificed	0	124	120	148	122
122	183 Minutes	8.1	175.5	Sacrificed	0	124	136	190	170

* Reading No. 1 was taken before beginning the experiment.
Reading No. 2 was taken just before the death of the animal.

suffered major hemorrhage and that the remaining two received insignificant trauma. We know that protection is afforded against the development of pulmonary edema by simultaneous blood loss in animals receiving rapid intravenous infusions. None of the sympathectomized animals included in this series sustained similar hemorrhage.

No difference could be noted in the animals in which bilateral dorsal sympathectomy had been performed and those which had had unilateral (right) sympathectomy, with the exception of dog No. 228b). Autopsy examination of the lungs of animal No. 228b revealed large amounts of frothy blood tinged fluid in all the bronchi. In the remaining eight animals small amounts of fluid were found only in those areas of the lung fields exhibiting evidence of trauma.

B. The Effect of Dorsal Sympathectomy on the Occurrence of Pulmonary Edema Following Bilateral Cervical Vagotomy.

The controversy concerning the effect of bilateral cervical vagotomy in the rabbit, guinea pig and rat has been referred to above. Farber has used bilateral cervical vagotomy followed by intravenous infusions of isotonic saline as a method for the rapid production of pulmonary edema in the rabbit.[19]

We have repeated this procedure in 15 dogs. The results are recorded in Table II. In all of these experiments a large rubber tube was placed in the trachea to a level well below the larynx. We could note no evidence of respiratory obstruction in any of these animals. Most of them breathed more quietly than normal animals receiving similar infusions. A peculiar jerking type of respiration was occasionally noted with no correlation with the presence or absence of edema. A similar type of respiration was noted in other animals without vagotomy.

Wide-spread collections of frothy blood-tinged fluid developed in the lungs of eight animals. In six of the eight, the amounts of fluid were so great that considerable quantities were expelled from the tracheal tubes before the animals were sacrificed. In one (No. 73) there was a moderate diffuse pulmonary edema. In six animals the lungs remained dry and were normal in appearance at autopsy.

We felt in the early experiments that the time interval between vagotomy and infusion might be of importance. Five of the first seven animals developed wide-spread edema. The two not developing edema in large amounts (No. 73, 74) were infused much sooner after vagotomy than the remainder. However, there is no correlation between the time interval and the presence or absence of edema in the next eight experiments, in only three of which wet lung developed.

The procedure of bilateral cervical vagotomy plus isotonic saline infusions was also carried out in nine dogs with previous dorsal sympathectomy. These experiments are recorded in Table III. Bilateral sympathectomy had been performed in two animals and unilateral sympathectomy in seven.

Three animals developed a significant amount of pulmonary fluid (Nos. 78, 79 and 145). In two of these animals the experimental procedure was begun within an hour after unilateral sympathectomy was performed (Nos. 78 and 79). In the remaining seven experiments an interval of from five to 21 days elapsed between sympathectomy and the attempt to produce wet lung. Only one animal in the latter group developed wide-spread pulmonary edema.

Examination of Tables II and III reveals that there are no significant variations in the peripheral blood pressures or pulse rates, rates of infusion or total amounts of fluid infused which can be correlated with the presence or absence of edema in these animals, either with or without sympathectomy. However, the time interval between sympathectomy and the experimental procedure appeared to be significant.

C. The Effect of Infusions of Isotonic Sodium Chloride Solution Within 45 Minutes After Unilateral Dorsal Sympathectomy.

In the preceding experiments we have noted a decreased incidence of wet lungs in dogs with dorsal sympathectomy, either bilateral or unilateral, performed five to 21 days before the experimental procedures. This was not true in two instances (Nos. 78 and 79, Table III) in which unilateral dorsal sympathectomy was performed within 60 minutes of the experimental procedure. Furthermore, pulmonary edema of slight to moderate severity was observed at the autopsy of three of ten animals expiring within 24 hours after dorsal sympathectomy.

The group of experiments summarized in Table IV includes seven mongrel dogs. Infusions of isotonic sodium chloride were administered to five of the animals within 45 minutes after unilateral dorsal sympathectomy. Pulmonary edema developed in three of the five, the quantity of pulmonary fluid varying from slight to excessive. Two more animals were treated in the same manner with the exception that the sympathetic chain was left undisturbed. These animals were given large amounts of saline. They developed no pulmonary edema.

DISCUSSION

"Traumatic wet lung" has been demonstrated experimentally in dogs. (See Part I.) Anoxia and the irritating effects of dispersed blood were offered as explanations for the occurrence of edema in areas of the lungs which exhibited evidences of trauma. We were unable to explain the frequent occurrence of pulmonary wetness in grossly untraumatized areas of the lung fields or its diffuse distribution when infusions of isotonic sodium chloride were administered following thoracic trauma.

Rapid improvement often followed the use of intercostal or paravertebral nerve block in the treatment of traumatic wet lung among the wounded of World War II. Brewer and others[2] have suggested that reflexes responsible for the syndrome were blocked by this procedure. The beneficial effects of nerve block are certainly due in part to the relief of pain.

TABLE III.—*The Effect of Dorsal Sympathectomy Upon Wet Lung Produced by Vagotomy and Saline Infusions*

Animal No.	Sympathectomy	Time Between Sympathectomy and Expt.	Time Between Vagotomy and Infusion	Rate of Infusion (cc/kg/Min.)	Amount of Saline Infused per Kg. Body Wt.	Cause of Death	Amount of Pulmonary Fluid	Arterial Blood* Pressure Mm. Hg. 1	Arterial Blood* Pressure Mm. Hg. 2	Pulse Rate* 1	Pulse Rate* 2
78	Unilateral	17 Minutes	32 Minutes	7.4	237.2	Sac.	3+	180	140	152	125
79	Unilateral	60 Minutes	12 Minutes	11.4	135.4	Expt.	3+	92	72	106	82
145	Unilateral	18 Days	43 Minutes	8.6	300.0	Sac.	4+	132	138	114	120
X-42	Unilateral	14 Days	39 Minutes	8.9	222.2	Sac.	0	164	160	120	126
219	Unilateral	8 Days	41 Minutes	9.9	257.4	Sac.	0	138	108	118	118
X-15	Unilateral	7 Days	36 Minutes	10.2	265.5	Sac.	1+	106	94	134	114
306	Unilateral	21 Days	61 Minutes	6.6	282.3	Sac.	0	106	104	120	126
7b	Bilateral	8 Days	23 Minutes	10.6	264.4	Sac.	0	132	118	120	116
67b	Bilateral	5 Days	53 Minutes	16.8	319.2	Sac.	0.5+	138	114	106	109

* Reading No. 1 was taken before beginning the experiment.
Reading No. 2 was taken just before the death of the animal.

TABLE IV.—*The Effect of Intravenous Infusions of Saline Immediately Following Dorsal Sympathectomy*

Animal No.	Operation	Rate of Infusion cc/kg/Min.	Amount of Saline Given Per Kg. Body Weight	Cause of Death	Amount of Pulmonary Fluid	Arterial Blood Pressure* Mm. Hg. 1	Arterial Blood Pressure* Mm. Hg. 2	Pulse Rate* 1	Pulse Rate* 2
80	Sympathectomy	11.7	246.3	Sacrificed	3+	72	72	100	75
86	Sympathectomy	19.7	266	Sacrificed	4+	90	60	92	74
90	Sympathectomy	10.0	200	Sacrificed	0	110	88	164	164
92	Sympathectomy	8.5	213.6	Sacrificed	0	130	168	142	156
95	Sympathectomy	9.4	217.4	Sacrificed	2+	126	102	160	144
81	Thoracotomy	8.3	350.9	Sacrificed	0	144	92	151	136
83	Thoracotomy	12.1	277.7	Sacrificed	0	120	124	126	130

* Reading No. 1 taken before infusion was begun.
Reading No. 2 taken just before the death of the animal.

Detakats[43] has observed reflex broncho-constriction following experimental blunt trauma to the thoracic cage. Burford and Burbank[3] felt that broncho-constriction of similar origin might be of importance in traumatic wet lung.

Pulmonary edema has been observed following central nervous system disturbances of many types in the absence of significant cardiac disease.[23, 24, 25] It has also been observed experimentally following bilateral cervical vagotomy.

Farber[19, 26, 28] using rabbits and guinea pigs reached the conclusion that the pulmonary edema which follows bilateral cervical vagotomy is due to reflex alterations in the pulmonary vessels. Reichsman[23] working with rats concluded that inspiratory obstruction was the primary factor.

The presence of a vasomotor control of the pulmonary vessels is a controversial subject, whereas the reactions of the bronchial musculature are well established.[40, 41] Daly[33] believes that vasoconstrictor fibers are distributed to the pulmonary and bronchial vessels through branches of the vagi as well as the sympathetic nerves in the dog. Hamilton and his co-workers[32] feel that the vasomotor control of the pulmonary arterioles is a feeble mechanism. A consensus of opinion is that such a control does exist, but that it is of less importance than the systemic vasomotor mechanism.[42]

Karsner[35] has described nerve fibrillae in the pulmonary artery of the dog. Larsell[36] has described the innervation of the human pulmonary and bronchial arteries and capillaries which he states is apparently of post-ganglionic sympathetic fibers.

The sympathetic supply to the lungs arises from T_1 to T_4 or T_5 and is distributed to the lungs through the inferior cervical and the corresponding dorsal ganglia.[38] It is bilateral in distribution.[39]

In this paper we have reported a number of experiments on the effects of unilateral and bilateral dorsal sympathectomy. Dorsal sympathectomy refers to the removal of the inferior cervical and the first four dorsal sympathetic ganglia with the intervening chain.

Two methods of producing "wet lung" have been used,[1] Blunt thoracic trauma followed by infusions of isotonic sodium chloride as described in our previous paper.[2] Bilateral cervical vagotomy followed by infusions of isotonic sodium chloride as described by Farber.[19]

Whereas wet lung can be produced with regularity by blunt trauma to the thorax followed by intravenous saline infusions, significant wide-spread collections of pulmonary fluid developed in only one of nine animals subjected to the same procedure seven to 21 days after dorsal sympathectomy. Bilateral sympathectomy had been performed in five of these animals, unilateral sympathectomy in four. However, dorsal sympathectomy had no effect on the occurrence of edema in areas of the lungs which exhibited evidence of trauma.

Bilateral cervical vagotomy followed by saline infusions did not produce wet lung with the same regularity as did trauma and saline infusions. It

developed in nine of 15 animals. We could not predict in which animals edema would occur. On the other hand, generalized pulmonary edema occurred in only one of seven animals in which unilateral or bilateral dorsal sympathectomy had been performed five to 21 days prior to the same experimental procedure.

The time interval between the sympathectomy and the experimental procedure employed to produce generalized pulmonary edema was of no importance within the limits of five and 21 days. When the intravenous infusion of saline was begun soon after sympathectomy, however, the removal of the sympathetic chain appeared to have no influence upon the occurrence of wet lung.

The experiments reported in this paper were designed to determine the importance of the autonomic nervous system in wet lung, particularly as it is related to thoracic trauma. No attempt was made to study the specific changes in physiology which were operating other than observations on the peripheral arterial blood pressure and the pulse rate.

We believe that a reflex mechanism does exist which plays an important role in generalized wet lung which follows thoracic trauma. In the dog, the removal of a large portion of the sympathetic nerve supply to the lungs tends to prevent diffuse pulmonary edema produced by the methods which we have described. Whether these reflexes have their greatest effect upon the pulmonary blood vessels or the bronchi and bronchioles, we do not know.

SUMMARY

The effects on experimental "wet lung" of excision of large portions of the pulmonary sympathetic supply have been studied in the dog. The results of these experiments indicate that generalized wetness following local trauma to the thoracic cage and the lung is in part a reflex phenomenon.

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DISCUSSION.—DR. JAMES M. MASON III, Birmingham, Alabama: Doctor Daniel's paper was excellent. I have nothing to add to his experimental work on the problem of "wet lung." From the practical standpoint, however, I wish to say a few words. During the war we encountered wet lung very frequently in chest injuries and in other types of wounds. We see it in civilian life in traumatic and elective surgical cases. The simple procedure of intercostal nerve block with novocaine is very helpful. When considerable fluid is being poured out into the bronchial tree, bronchoscopy or tracheal catheterization with suction will prove helpful. In this condition the judicious use of the bronchoscope has saved many lives.

FACIAL PARALYSIS SUPPORTED WITH AUTOGENOUS FASCIA LATA*

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PARALYSIS OF THE SEVENTH nerve presents one of the most difficult problems, and procedures in plastic surgery for such patients are considered when there is thought to be no chance of nerve recovery or of nerve operation. It also may be useful to support the face during a waiting period in the process of nerve recovery or of neuro-surgical work.

It is best to realize from the start that a rather crude substitution is about all that can be done. The finely kinetic actions of the muscles of the face, supplied by the seventh nerve, such as the gentle approximation of the eyelid to the globe—awake or asleep—and the delicate movements of emotional expression, hardly can be expected to be normally restored by the substitution of a few points of suspension with fascial loops or muscle flaps. And so—as in much of plastic surgery where missing parts have to be supplied—a substitution has to be made.

Most patients have been so distraught with their plight, but are so cooperative and appreciative that it is necessary to strive for the procedure which will produce the most effective substitution.

The use of fresh autogenous strips of fascia lata, continues to be one of the basic methods of support, although there are several other procedures for supporting the face with various degrees of efficacy being obtainable. These strips are anchored in the temporal (fifth nerve) muscle and fascia and looped down through the face in two or more levels. The bulk of the face is elevated to an overcorrected position and the loops are anchored securely. The utilization of the temporal muscle and its fascia and strips of fascia lata has been reported elsewhere,[1-3], and at this time additional findings and points worthy of emphasis are recorded.

Time for operation, is important and paradoxically it is before much sagging of the face has occurred. It is usually not done in early childhood, but it probably could be done then. One boy we saw with double congenital paralysis seemed an ideal type to try to help, but so far the parents haven't agreed. This is such a striking deformity that almost any improvement would be acceptable. We have done patients after 40 years of paralysis, but these are apt to be the most difficult because of the long standing soft tissue sag and redundancy. In these patients, the mouth and lip and nasal level can be elevated, but the excess tissue falls over like a tent or an awning. Heavy thick or edematous faces are not helped greatly by this procedure, that is if the face can't be pulled into a satisfactory position before operation, then the fascial strips can't be relied on to do it either.

* Read before the Southern Surgical Association at Hollywood Beach, Florida, December 9, 1947.

Excision of excess skin, can be done, preferably before or after the fascial transplant operation. Wide undermining and tension is necessary, and it is usually thought best not to add this to the transplantation as there is the necessity of firm healing over the fascial loops in the temporal region. Suturing of the fascial loops is possibly best done with fine wire, though cotton or silk may suffice.

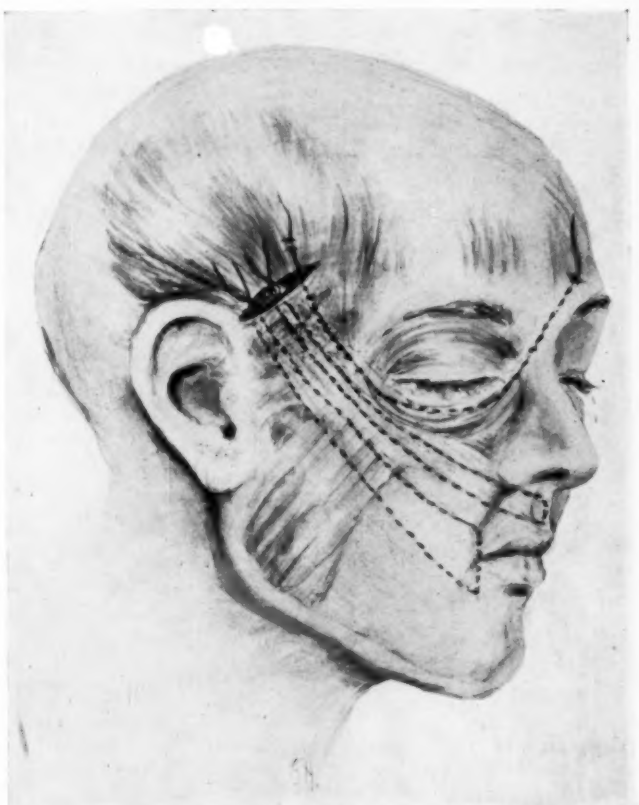


FIG. 1.—Shows course of fascial loops through face to upper lip, angle of mouth, and lower lip. These are anchored in the temporal muscle and fascia. The loop through the lower lid is anchored in the opposite frontalis region and in the temporal fascia, not in the temporal muscle.

Improvement in comfort of the eye is one of the main objectives. This is obtained by (1) the elevation of the tissues with the large loops in the face. Patients even may be able to close the eye from this element alone. (2) An external canthoplasty of 4-5 millimeters is usually productive of increased comfort and improved appearance. The extra sclera that nearly always shows up is hidden quite well by this procedure. The approximation of the lids is done along the tarsal border so that the lashes remain and there is not too much evidence of the partial closure, without close scrutiny. (3) A separate loop of fascia can be anchored in the temporal fascia on the outside, carried through

the lid, and fastened in the opposite frontalis muscle. This is a pretty fine adjustment to make in such a gross manner and it is not relied on if it is thought that the general elevation and the canthoplasty will suffice. The fascia is apt to form a little ridge as it goes across the side of the nose, but this is not too objectionable. (4) A flap of opposite frontalis fascia or muscle, or both, can be brought down and an attempt made to tighten the lid sag with it; or the flap may come from the temporal region. (5) The production of a Horner's syndrome is mentioned but has not been relied on by us. It would seem contraindicated if there was marked sagging of the brow. Closure of the eye is improved in most patients, and even though it is not complete in sleep, they nearly all have

A B

FIG. 2.—A. B. Complete paralysis elevated with fascial loops. The eye can practically close from the 2 major loops alone. B, C, D and F are 6 mo. after A and E.

good Bell's signs (of rotating the eyeball up on closure), so that the cornea is rarely exposed. Some patients are able to keep the eye fairly well closed even in sleep.

A nasolabial fold is important for balance of the face—absence of it, and droop of the upper lip is perhaps the most noticeable feature of seventh nerve paralysis, when the face is in repose on the opposite side. It is important to try to reproduce a semblance of this fold, and it comes in by adequate elevation of the angle of the mouth; at operation this area is so overcorrected that the face is distorted.

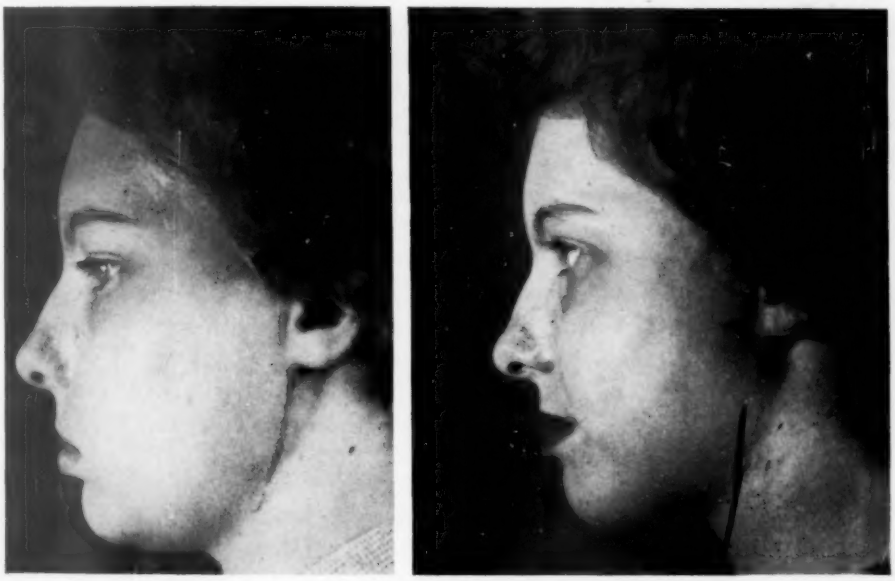
Movement of the paralyzed side is possible by pull of the temporal muscle, but not too much is desirable because of its being noted too much on eating. But this movement is advantageous, and with a little effort many patients can substitute it for a little emotional expression. A smile can be simulated by the above action, and along with a nasolabial fold, these probably give the patient

C D

FIG. 2. C. D.—If not much activity or emotion is expressed on the sound side the symmetry is close to normal.

his most normal appearance. Improved eating is nearly always obtained by the supported cheek holding food better during mastication.

Training of the opposite normal side is very important, and the patient who can control the degree of his emotional expression in laughing and in conversation, even though he has to be a little glum, will help the surgical result materi-



E F

FIG. 2.—E. & F. Six months after fascial transplantation. The profile is improved by the elevation of the fascial loops.

ally. The training is usually easy and is carried out by the patient himself with the aid of mirror exercises.

Partial facial paralysis may be improved by adding fascial support, but nothing should be done to interfere with any "tone" of the facial muscles that might be getting in through any nerve channel. Even an unsuccessful nerve operation or anastomosis should not be taken down or interfered with if any "tone" at all is being supplied. The grimaces that may result from anastomosis and the mass movements that may occur following nerve suture, may possibly be improved by fascial support, and training.

The needles for threading the fascia through the face should be as simple as possible. Complicated Reverdin or locking types are cumbersome and unnecessary. The simple types shown here are rigid pieces of steel mounted on handles with slotted eyes in the pointed ends. One is for the face loops and one to go around the eye —through the lid. These were made originally for one of us by Dr. Richard Douglas Saunders. The heavy facia needle to carry the loops through the temporal muscle can be improved by enlarging the eye with a file. Pressure dressings using cotton mechanics waste are always relied on, and the face is supported with adhesive for two to three weeks.

FIG. 3.—Simple needles, slotted at the point used for the long loops thru the face, and for the loop thru the eyelid.

The drooped eyebrow can be improved by elevation and excision of tissue up in the hair line, or a separate loop of fascia may be tried, anchored high enough.

Secondary Adjustments are done as necessary and include: adjustment of the loops, and excision of excess skin above in the hair region. Very rarely is any excision of skin done in the face, but in long-standing instances and where the face falls over the fascial strips like an awning, some adjustment may be necessary in the nasolabial region or close to the angle of the mouth.

Complications are mainly as listed in adjustments, but as in all plastic surgery—infection is the main complication. So much depends on the healing of these wounds and so slight an infection militates against a desired result that every effort should be taken to prevent contamination and infection.

Results are far from what we would like for these patients, but as illustrated by the following they may be worth while. Her eye can close; in repose she looks about normal; she has a slight smile; and by training to avoid over-action of the sound side, she gets by with many persons who see her, not realizing that her face is paralyzed.

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PRESERVATION AND RESTORATION OF MANDIBULAR FUNCTION AND CONTOUR*

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MANDIBULAR FUNCTION AND CONTOUR are often jeopardized by operations, trauma, or infection. Immediate measures for preservation of function may suffice or be supplemented with secondary repair.[3]

LIMITATION OF MOUTH OPENING

Trismus is a temporary inelasticity of the soft tissues between the jaws resulting from inflammation. Permanent fixation may be the result of several factors and may be classified as true or false ankylosis, depending upon whether or not the temporomandibular joints are involved. An accurate diagnosis of the cause is essential.

Surgery, trauma or infection in the neighborhood of the temporomandibular joints may result in either bony or fibrous obliteration of the joint (Figs. 1 and 2). Frequently the causative trauma is extensive and in addition to joint obliteration the coronoid process may be anchored to the zygoma. In such conditions adequate resection of the joint area, including the coronoid process if necessary, will give relief. More dependence should be placed on the adequate removal of bone at the site of the resection than on the application of some substance between the resected ends. All bone forming detritus must be removed.

This resection is commonly done from in front of the ear, reflecting the parotid gland and facial nerve forward and downward and elevating these structures outward from the bone. In certain simpler conditions it may be done from within the mouth. The most difficult ankylosis, represented by a broad, thick mass of bone and a short ramus, had best be approached from the neck, elevating all soft tissues, including the facial nerve and parotid gland, from the ramus of the mandible, beginning the resection on the ramus above the angle and working upward to include the condyle and coronoid process (Fig. 1). Such a resection causes very little dysfunction except to diminish the power of the bite and does not disturb dental occlusion, as does removal of the body of the mandible.

False ankylosis often follows depletion of the soft tissues connecting the jaws. Loss of mucosa, the full thickness of the cheek, or the skin of the cheek, if in large amounts, will have this effect. The removal of superficial lesions of cheek mucosa may be followed immediately or later by replacement with split thickness skin grafts. Deeper losses may require replacement with a pedicle flap.

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* Read before the Fifty-ninth Annual Session of the Southern Surgical Association, December 9-11, 1947, Hollywood, Florida.

A B

FIG. 1—Ankylosis of 30 years' duration from infection in childhood. A. Note underdevelopment and asymmetry of mandible. Previous operations done elsewhere had failed because of reformation of bone at the site of the resection. Complete removal of the short, thickened ramus from angle up to the base of the skull on the affected side gave good mouth opening. The normal joint, though not used for 30 years, rapidly regained function. B. Note improvement of contour by overlaying mandible with implants of cartilage.

A B

FIG. 2.—A. Partial ankylosis and paralysis of lower branch of facial nerve, from infection in infancy. B. Correction of ankylosis by resection of temporomandibular joint by a direct approach from in front of the ear, resecting an adequate amount of bone to prevent re-ankylosis.

Subsurface scarring in the region of scant clearance between the coronoid process and zygomatic arch may cause firm fixation in a closed position. Adequate resection of the coronoid process from within the mouth to release one point of scar anchorage will give relief. Depressed fractures of the zygomatic arch will produce impingement on the coronoid process, preventing mouth opening **(Fig. 3).**

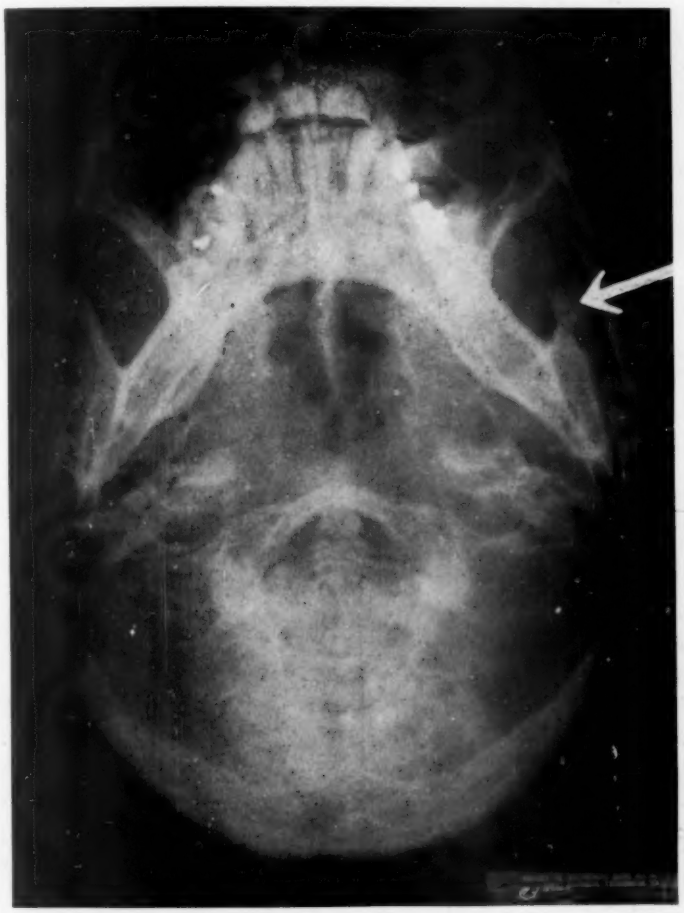


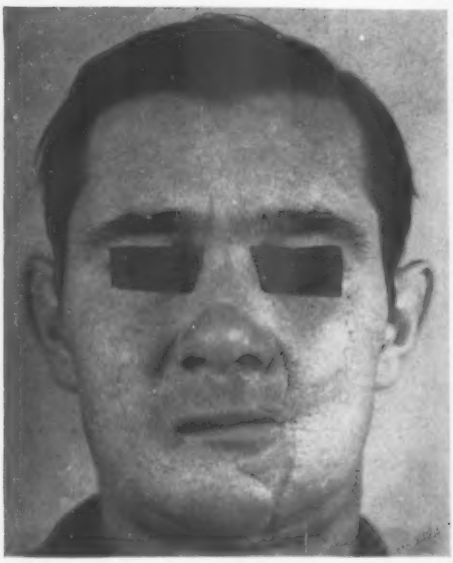
FIG. 3.—Illustrating one typical cause of limitation of mouth opening following fracture. A fragment of bone from the zygoma has been driven inward, impinging on the coronoid process, blocking its excursion. Removal of the coronoid process from within the mouth gave normal mouth opening.

SOFT TISSUE CONSIDERATIONS

At the time of injury or resection all possible soft tissue must be preserved (Fig. 4). In treating acute injuries of the face, debridement is not practiced to the extent often employed in wounds of other parts of the body. In operations for cancer large areas of soft tissues may be destroyed and

replaced later. Before a bone graft to the mandible is done, adequate covering for the graft must be present. If the quality or amount of tissue is

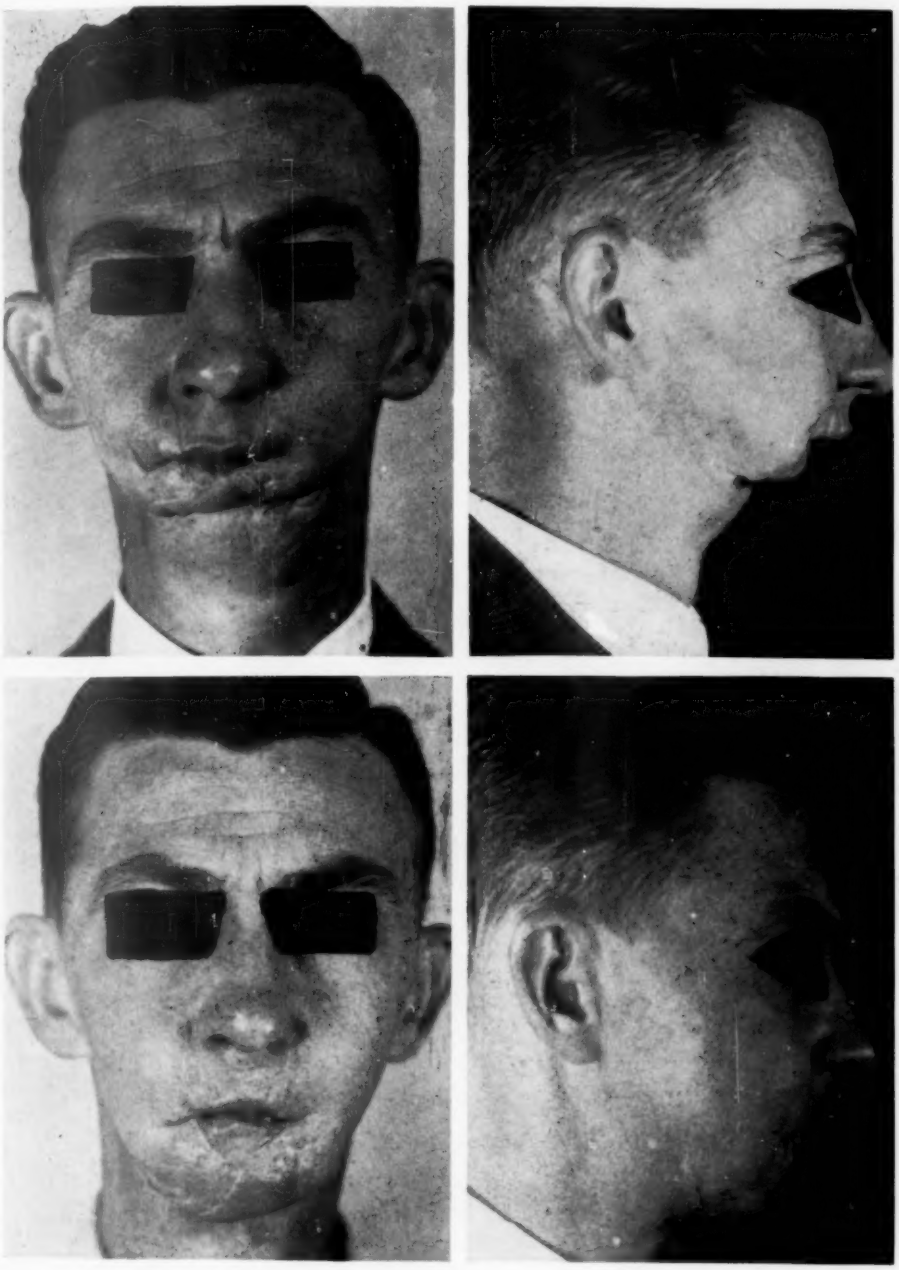
A



B C

FIG. 4.—A. Extensive loss of soft tissue and bone of the symphysis region from gun shot wound. B. Result obtained at primary repair. All soft tissue possible was preserved. The remaining bone fragments were held in their proper relationship by interdental wiring. Note good contour of lower third of face as compared with narrowing from similar injury on patient shown in Fig. 5. C. Result following use of pedicle flap to inside and outside of mouth and successful bone graft to mandible. Pedicle flap similar to that illustrated in Fig. 6 was used.

A



B

FIG. 5.—A. Extreme soft tissue and bone loss from gun shot injury. Note narrowing of lower portion of face due to inward displacement of remaining bone fragments. B. Restoration by means of added soft tissue (Fig. 6) to give adequate covering for a bone graft and restoration of mandibular continuity by the use of two ribs extending from angle to angle, a double thickness of rib being used at the symphysis. Previous attempts at bone graft done elsewhere had failed because of inadequate soft tissue covering. (*Surg., Gynec., & Obst.*, 84: 870, 1947.)

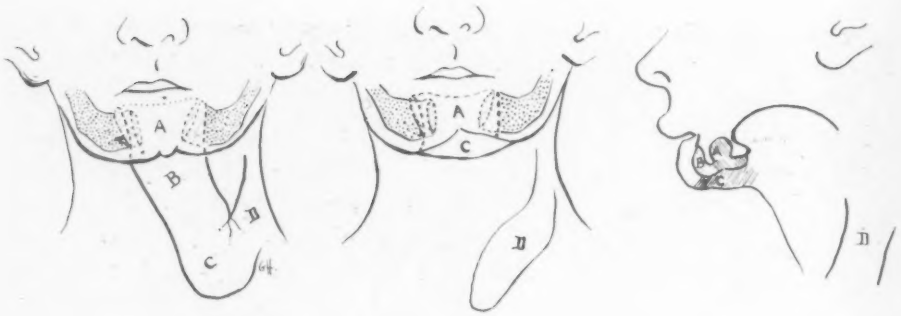


FIG. 6.—Diagram illustrating source and use of the pedicle flap for restoration of soft tissue loss in patient shown in Fig. 5. The tip of this flap was let into the mouth through a submental incision to replace the constricting and inadequate scar tissue between the ends of the bone. The center portion of the flap was used to line the labial sulcus; the proximal portion supplied the external covering of the chin and submental area; and the base of the flap was returned to the neck. (*Surg., Gynec. & Obst.*, 84: 870, 1947.)

A

B

FIG. 7.—A. Original lesion was radiation necrosis of mandible and overlying skin of the cheek, lip, and chin. Patient shown after removal of damaged bone and full thickness replacement of soft tissue with pedicle flap from the lower neck and upper chest (Fig. 6). Continuity of the bone not re-established. B. Improved contour of the mouth and lower face following rib bone-cartilage graft to restore continuity of mandible and support of the soft tissues of mouth and pharynx and contour of face.

inadequate to cover the graft easily and heal readily afterward, it must first be supplemented with a skin graft pedicle flap, or by mobilization of local tissues. (Figs. 4, 5, 6, 7, 8).

Frequently the loss of a section of mandible is followed by a failure to maintain the remaining fragments in their proper relationship. This permits the ends of the bone to drift together by scar tissue pull so that the space occupied by the original fragment is no longer present. Under such circumstances the contracted scar tissue must be removed before a bone graft can be done. In some instances following this procedure a pedicle flap must be inserted prior to bone grafting.

MANDIBULAR RESECTION

Removal of a section of the mandible creates an immediate problem in management of the remaining fragments.[1] If not held in proper relationship, muscle pull may displace the fragments medially and backward, narrowing the pharangeal

FIG. 8.—X-rays of patient shown in Fig. 7, mandibular restoration having been made with a rib and attached cartilage, the costochondral junction simulating the angle of the mandible. The inked-in portion represents unvisualized cartilage. Splinting was obtained by driving threaded bar into symphysis and impaling rib on this. The rib symphysis junction was strengthened by applying periosteum taken from other ribs. The cartilage end works in a soft tissue pocket in the region normally occupied by the upper ramus. In this particular type of restoration ordinary methods of splinting are not applicable.

TABLE I.—*Appliances Adequate to Control Fragments of Mandible Both after Resection and Bone Graft* *

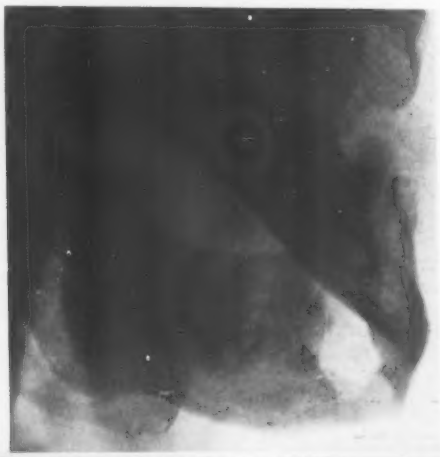
A
Posterior Fragment Edentulous
a. Arch bar or splint on mandible with posterior extension to hold posterior fragment in line
b. As in "a" except splint attached to maxilla, supplemented by interdental wiring
c. Internal bar fixation (Figs. 8, 9, 10, 11, 12)
B
Both Fragments Edentulous or Teeth Not Suitable for Use
a. Open bite splint with circumferential wires (possibility of infection of bone graft)
b. Internal bar fixation (Figs. 8, 9, 10, 11, 12)

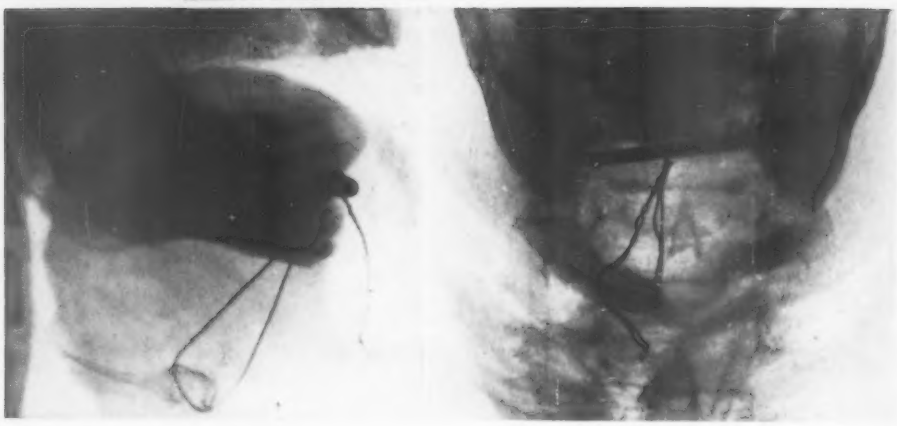
* Many appliances suitable for control of fragments after resection are not equally suitable for splinting bone graft because of danger of infection.

funnel, shutting off the airway, and making swallowing both painful and difficult (Fig. 9). When such a patient survives these initial hazards, the secondary repair of the bony defect is needlessly complicated by the necessity of restoring these fragments to their original relationship before the bone graft can be done. At the time of resection an accurate and careful soft tissue closure must be made, minimizing the drag of a contracting wound. Mandibular resection is usually performed as a planned proce-

dure so that an adequate scheme is prepared in advance.[1] Occasionally, however, one may be faced with a traumatic loss of bone, creating the same problem (Fig. 4). The simplest scheme for the control of bone fragments is to wire the teeth of the fragments to their corresponding maxillary teeth

A





B C

FIG. 9.—A. Roentgenogram of fibrosarcoma of the symphysis. B. and C. Same patient following resection of symphysis area with removal of considerable soft tissue. Symphysis resections especially jeopordize breathing because of the detachment of muscle support to the hyoid bone. The internal bar has been inserted in the fragments and the larynx is held forward in normal position by a stainless steel wire passed around the hyoid bone. Eventually this wire was removed. The bar has remained in place without complication. (*Surg., Gynec., & Obst.*, 84: 870, 1947.)

(Fig. 14). In the edentulous patient or in children, where dental development is inadequate, or in dealing with small posterior fragments, this method is not available. Table I indicates the mechanical possibilities which may be used to retain the fragments at the time of resection or as splints at the time of bone grafting under difficult conditions.

INTERNAL BAR FIXATION

A method of fixation applicable to traumatic loss of bone under adverse circumstances is the insertion of a bar of tantalum or stainless steel between the ends of the bones, replacing the resected or lost fragment with this sub-

FIG. 10.—Mandible of an 85 year old man resected along with removal of large amount of soft tissue in treatment for carcinoma of alveolar mucosa. The internal bar as shown preserves pharyngeal support during the immediate postoperative period and although eventually extruded or removed, has remained in place in similar cases, sometimes for many months, giving the patient maximum comfort, even though age and prognosis do not warrant restoration of mandible. (*Surg., Gynec., & Obst.*, 84: 870, 1947.)

stitute[3] (Figs. 9, 10, 11, 12). Surprising rigidity results from this procedure, which may be regarded in some instances as a permanent splint for subsequent bone graft (Fig. 12), or in other instances merely as a temporary

stop-gap to carry the patient through the trying immediate postoperative time and the later period of wound healing (Fig. 10). Not infrequently mandibular resection with widespread soft tissue destruction is performed in cancer patients where restoration of mandibular continuity is not contem-

A

B C

FIG. 11.—A. X-rays of mandible of an 8 year old child showing tumor later diagnosed microscopically as ossifying fibroma. B. X-ray following subperiosteal resection and insertion of stainless steel bar to control remaining fragments. No further fixation was employed and patient left the hospital healed in ten days. C. X-ray taken 28 months after operation showing strongly regenerated mandible and presence of original internal splint. The patient now is in her third postoperative year without any evidence of trouble from the stainless steel bar. X-ray evidence of regeneration was visible 7 weeks after the resection. The face is symmetrical. (*Plast. and Reconstruct. Surg.*, 1: 238, 1946.)

plated. Here it is desirable to maintain function as far as possible for the comfort and well being of the patient, as well as to have the remaining fragments eventually in as good a position as possible, even though their continuity has not been restored. Internal bar fixation has been very valuable under these circumstances. Such fixation has been maintained without difficulty for several months, in some instances, years, eventually working free. During this period, however, the open wound has healed without contracture,

which would pull the remaining fragments well out of position, had not such fixation been maintained. Even though the patient's age and disease may not warrant complete repair, the disability has been minimized. One extremely difficult problem has been the replacement of half the mandible following resection and disarticulation or resection at the symphysis and high on the ramus, so that the posterior fragment cannot be utilized in the attempted repair. The method which we have most commonly employed has been the use of a rib with its attached cartilage forming a curve simulating the angle and ramus of the mandible, the rib portion representing the body of the mandible (Fig. 7). With this type of repair the cartilaginous end has been

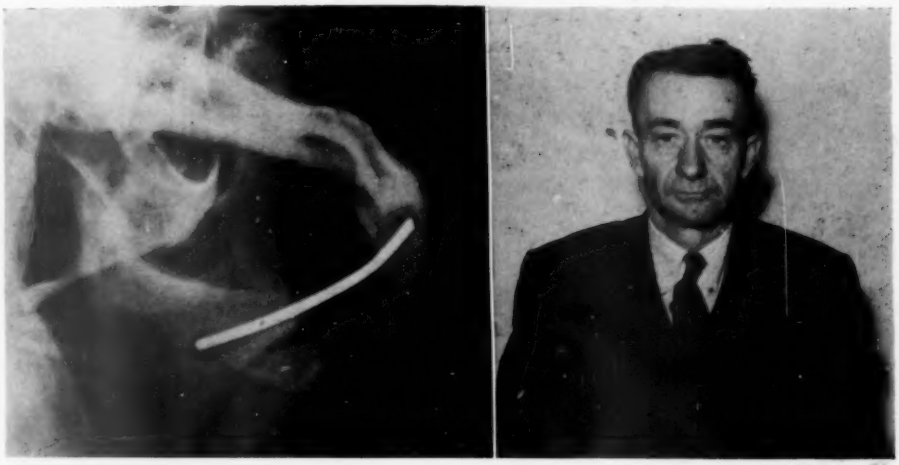


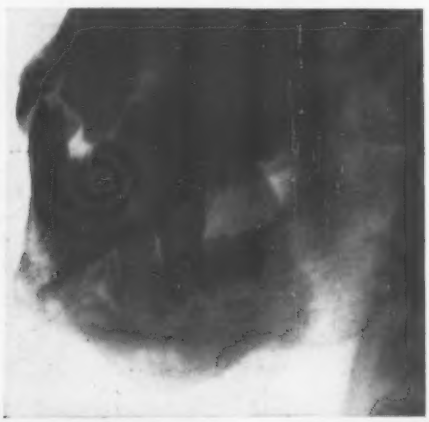
FIG. 12.—*a*. X-ray of resected edentulous mandible showing stainless steel bar inserted at time of resection and still in place six months later, having served as a splint for a bone graft done three months after the resection. No fixation or splinting other than this was used. Union is solid to palpation. *b*. Appearance of the patient subsequent to bone graft. During the period prior to the bone graft and following the resection, patient was comfortable and could eat soft foods. On palpation the bone fragments were not held rigid but were stable and the patient was comfortable.

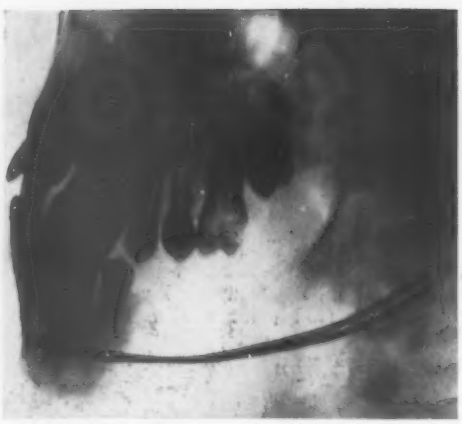
inserted in the region near the temporomandibular joint and has worked as a false joint supported by soft tissue. The problem has been to get adequate fixation of the rib to the symphysis, inasmuch as there is no splinting of this fragment other than at the symphysis. All movements of talking or swallowing have a tendency to cause motion in the transplant. The drilling of a threaded stainless steel bar into the symphysis and the impalement of the rib on this bar, bent to the line of replacement, gives firm and adequate immediate fixation, which has been satisfactory for the support of the implant until bony union to the symphysis has occurred (Fig. 8). It is desirable to supplement the junction of the implant with the symphysis with other bone-forming material because of the small amount of bone in apposition when the end of the rib is abutted against the symphysis.

SUBPERIOSTEAL RESECTION

Because resection of the mandible is a serious operation from the standpoint of disability, deformity, interruption of function, and difficulty of repair, it is desired to call attention to the operation of subperiosteal resection.[2] It has frequently been observed that the mandible will regenerate with sur-

A





B C

FIG. 13.—A. Destruction of mandible from osteomyelitis. There was a pathological fracture and subsequent sequestration of a large segment of mandible. B. Beginning regeneration 2 months later. C. Adequate regeneration 4 months after sequestrectomy. Similar regeneration occurs following subperiosteal resection. (*Surg., Gynec., & Obst.*, 84: 870, 1947.)

prising adequacy after the spontaneous sequestration of large segments following osteomyelitis (Fig. 13). Similar regeneration will occur following subperiosteal resection (Fig. 11). Obviously this procedure cannot have widespread application. Rarely would it be adequate in the treatment of any of the malignancies. Occasionally in dealing with the simpler tumors, such as adamantinomas, ossifying fibromas, or osteomas, which have caused extreme

A B

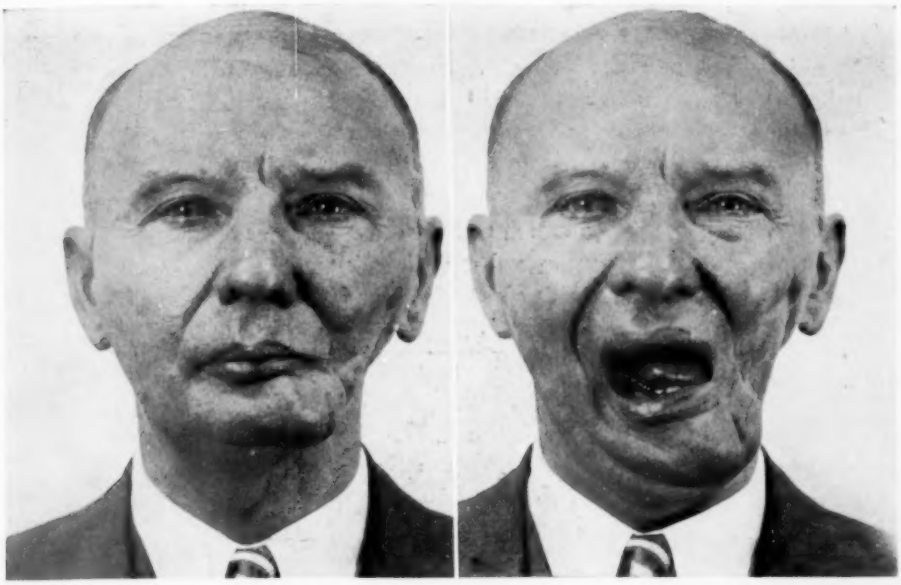


FIG. 14.—A. Resection of symphysis and disarticulation of half the mandible, along with removal of full thickness of the cheek for carcinoma. Such a wound may create sufficient traction in healing to displace remaining half of mandible markedly. Note relative symmetry of normal portion of face obtained by holding remaining fragment of mandible in occlusion throughout healing period. B. Mouth opening is possible because of the missing mandible on the left side. Such removal of soft tissue without replacement will greatly limit mouth opening if the mandible is intact. Maximum function short of reconstruction has been preserved. (*Surg., Gynec., & Obst.*, 84: 870, 1947.)

A B

FIG. 15.—A. Extreme microgenia from early childhood infection. Functional improvement to a marked degree is not feasible because of weakness of the bite. However, some improvement in function and a great improvement in contour was gained ("B") by (1) building forward the mandible with cartilage implants, (2) supplying additional soft tissue to the chin, (3) creating skin graft lined pocket inside the lip, and (4) fitting with denture, utilizing a few remaining teeth and the cartilage implant for support.

A B

FIG. 16.—A. Congenital underdevelopment of the mandible with good function. Improvement of contour sought for professional reasons. B. Building forward the mandible with cartilage implant gave much more pleasing contour.

A B

FIG. 17.—A. Congenital maldevelopment with unpleasing facial contour. B. Improved by bringing forward mandibular prominence with cartilage implant and correcting unattractive nose at the same operation by nasoplasty.

expansion of the bone, the entire thickness of the bone must be removed in order to effect a cure; but the periosteum is uninvolved and at least portions of it can be left bridging the gap between the ends. If these fragments are adequately controlled, regeneration will readily occur. In children especially the usual forms of splinting are often unsatisfactory, and in such cases internal bar fixation, counting on the bar to be permanent and to be rapidly supplemented as a supporting structure by regenerating bone, is the best scheme.

MANDIBULAR CONTOUR

In some instances of extreme underdevelopment or maldevelopment of the mandible, function cannot be restored to a normal degree because of

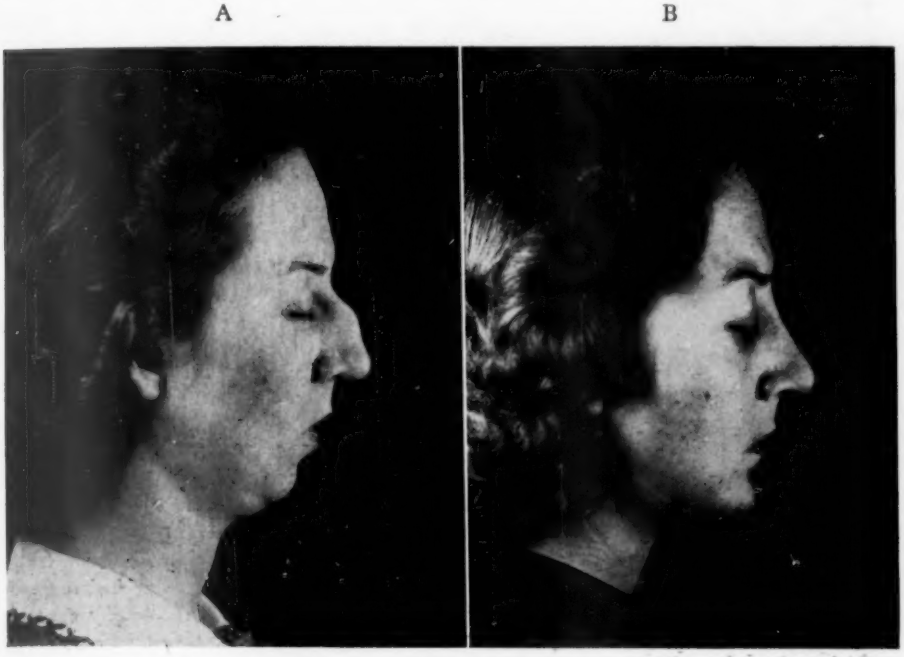


FIG. 18.—A. Condition similar to that illustrated in Fig. 17. B. Correction by cartilage implant to chin and nasoplasty. (*Surg., Gynec. & Obst.*, 84: 65, 1947.)

the lack of muscular power exercised by the closing muscles on the remnant of bone present. In such cases restoration of contour with good appearance of the patient is most important. In the extreme cases, not only must the solid prominence of the mandible be extended forward, but room for a denture to supplement the mandible still further must be created (Fig. 15). The first consideration involves the use of a cartilage or bone graft to the prominence of the mandible or to the flattened side, if asymmetry is present, to give as much prominence as possible (Fig. 1). In extreme cases soft tissue in the form of a pedicle flap must be supplied prior to the cartilage or bone implant in order to create room for it. Subsequently, additional space inside the lower lip must be obtained by the creation of a skin graft lined sulcus,

this combination building forward the solid portion of the mandible to form a shelf on which a denture can rest, and supplying room for the denture will give great improvement in appearance although there is little power to the bite. In less extreme cases where function is adequate, but the appearance is unpleasing, creating the missing contour with implants of cartilage applied directly to the bone as a single procedure will give good improvement in appearance. Such implants must be applied directly to the bone without a superimposed layer of soft tissue to insure solidity of the implant with the mandible (Fig. 16). Additional improvement in appearance may be often obtained by correction of other asymmetries of features, combining in some instances a nasoplasty with restoration of mandibular contour (Figs. 17 and 18).

OTHER CONSIDERATIONS

Fractures, limited removal of bone of the alveolus, as for tumor involving the alveolar ridge, or removal of soft tissue obliterating a sulcus, may interfere with the successful fitting of dentures. If an adequate alveolar ridge is present, the other factors usually may be corrected simply. Obliteration of the buccal sulcus can be corrected by adequate incision in the buccal sulcus and the application of a split thickness graft to maintain the depth of the sulcus.

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[2] Byars, L. T.: Plast. & Reconstruct. Surg., **1**: 236-239, 1946.
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DISCUSSION.—DR. TRUMAN G. BLOCKER, JR., Galveston, Texas: I have enjoyed Doctor Byars' presentation a great deal and recognize his vast experience in handling cases requiring jaw restoration. In the army, where a large number of jaw reconstructions were necessary, our patients came to us with such loss of soft tissue or such intensive scarring in the area of bony loss that it was impossible to maintain occlusion of the intact fragment. We found, however, that when the scar tissue was replaced by a supple pedicle, the fragments tended to return to their approximate normal position, occasionally requiring elastic traction.

The toothless posterior fragment, even though it may be considerably misplaced, can frequently be brought into proper alinement at the time of bone grafting by stripping its muscular attachments and forcibly bringing it into position with a wire placed through the angle.

I feel that Doctor Byars' method of placing a bar between the fragments has considerable merit. But where there is loss of soft tissue or where the bone is exposed, I would be hesitant to use an internal splint because of the danger of infection.

DR. LOUIS T. BYARS, St. Louis, Mo. (closing): I have heard this method of repair criticized and the statement made that good results often were not obtained by it. I believe when the results are disappointing it is because the operator does not have the courage to do the tremendous amount of overcorrection that is necessary and, in the subsequent relaxation, the support is lost. I have never seen one that was overcorrected, and I have seen a number where strips had been tightened or should have been tightened later.

PROLAPSE OF THE GASTRIC MUCOSA*

Report of Six Cases

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PROLAPSE OF THE GASTRIC MUCOSA through the pylorus has been considered an unusual phenomenon, and relatively few cases have been reported. The first case was reported by Von Schmieden in 1911.[1] Melamed and Hiller,[2] in a review of the literature in 1943, found only 19 cases reported. Scott[3] reviewed the admissions of a large Naval hospital for the years 1943-1944. In 19,288 admissions, 1,346 examinations of the upper gastro-intestinal tract were made, and in this group 14 instances of prolapse of the gastric mucosa were found, an incidence of 1.04 per cent. In the same series, 13 cases of gastric ulcer were found, an incidence of 0.96 per cent. Rees[4] found only four cases in 3,000 such examinations at the Rees-Stealy Clinic, and only two cases in 2,550 examinations at the San Diego County General Hospital. Archer and Cooper[5] believe that the disease occurs much more frequently than is commonly recognized, but they do not give the incidence. Pendergrass and Andrews[6] report that in the Department of Radiology of the University of Pennsylvania, the condition was diagnosed in 99 patients from 1923 to 1935. They do not, however, give the total number of examinations made during this period.

In a review of the last 97 examinations of the upper gastro-intestinal tract made at the white division of Grady Memorial Hospital, Atlanta, seven cases were diagnosed, an incidence of 7.2 per cent; in the last 100 such examinations in the colored division of Grady Hospital, nine cases were diagnosed, an incidence of 9 per cent; and in 100 gastro-intestinal examinations made at Emory University Hospital, 7 cases were diagnosed, an incidence of 7 per cent. Of the 297 total examinations reviewed at the two hospitals, 23 cases of prolapse of the gastric mucosa were found, a total incidence of 7.7 per cent.[7] Of the 23 cases, four were so extensive as to indicate eventual surgical treatment.

The condition is most often observed in patients in the fourth decade of life, although it has been seen in patients ranging in age from 20 to 80 years. Of the six cases presented here, five occurred in males. The incidence did not vary according to race.

ETIOLOGY. The etiology of prolapse of the gastric musoca is unknown. Eliason and Wright[8] suggest that it is the result of a low-grade inflammation of the mucosa produced by chronic irritation, and that it develops into a local hypertrophy. Once this hypertrophy begins, it is increased mechanically by contraction of the stomach, peristaltic waves, and the pressure of the gastric contents as they are forced by on their way to the pylorus. The mucosa is

*Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

thus pushed along or lengthened out in the direction of the pylorus, and it is eventually swept into the pylorus by a peristaltic wave, causing a ball-valve syndrome attack of pain. Rubin[9] concurs in this theory of an inflammatory origin but believes also that the resulting increase in peristalsis causes a progressive prolapse of the mucosa. Wolf and Wolff[10] found great variation in the thickness of normal mucosa, various stimuli causing large hypertrophic-appearing folds of mucosa which subsequently appeared normal. In three cases of prolapsed gastric mucosa treated surgically, Rees[4] found a "definite resistant narrowing of the pylorus and an apparent loss of muscular substance," suggesting a fibrous degeneration of the muscular tissue. He believes that this narrowing of the pylorus causes hyperperistalsis which in turn loosens the

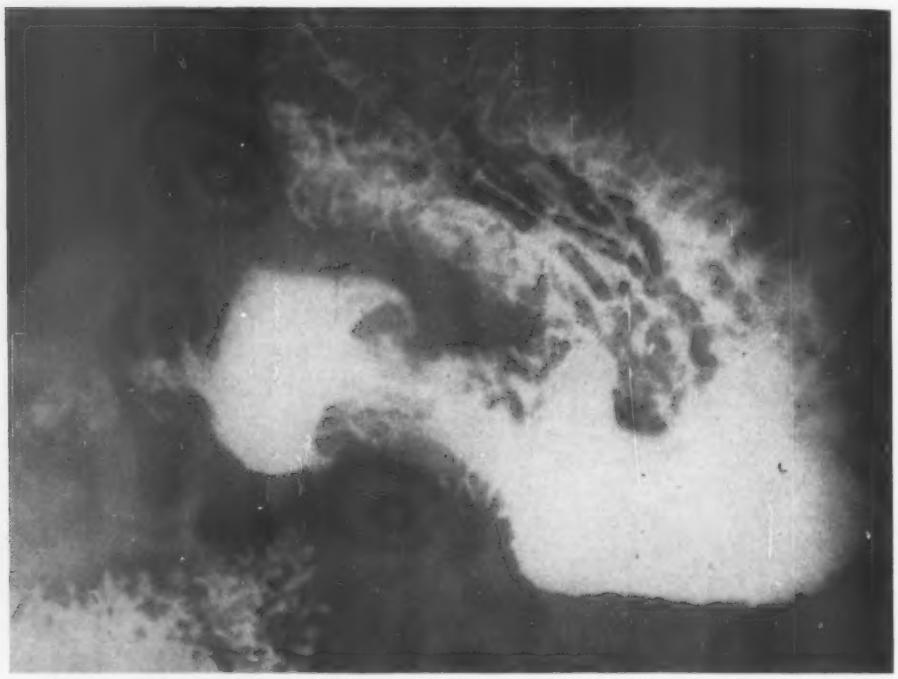

FIG. 1. Case 6: Upper left illustration shows extreme mobility and redundancy of the gastric mucosa. On the right is shown the rugae continuing down well past a normal pyloric aperture into the duodenum.

attachment of the mucous membrane to the muscularis in the constricted area, and that once the membrane is mobilized, the traction is transmitted by continuity to the antral mucosa, which is loosened in turn and eventually prolapses. He states that the condition is progressive and symptoms become more pronounced as the mucosa becomes more redundant. Scott[3] believes that none of these hypotheses will completely explain the condition. Rather, he believes that the mucosa becomes loosened as a result of stretching during normal gastric movements, and he cites Forssell's and Schindler's observations that the mucosa has a mobility of its own, and varies in size, shape

and position independently of the contractions of the muscularis. He states that "the one common denominator in the theories on the etiology of prolapse is an abnormal disturbance of gastric peristalsis and function. The most common continuous and effective means for altering gastric function springs from the emotions and the nervous system. Consequently, in view of the construction of the stomach walls, which normally permits a degree of mobility between them, it seems possible that certain neurogenic factors are the inciting cause of a disturbed gastric function that ultimately brings about a mucosal prolapse. A pre-existing disease process is not necessary for the production of a prolapse of the gastric mucosa."

PATHOLOGY. The pathology involved in prolapse of the gastric mucosa is a redundancy of the mucosa of the pyloric end of the stomach with greatly hypertrophied rugae. This area of mucosa not only becomes redundant, its mobility on the muscularis is greater than normal. Observation at autopsy has shown the mucosa of the normal stomach to be movable on the muscularis, but in no case sufficiently mobile to allow it to be drawn down into the duodenum. In the one case operated upon at Grady Hospital, there was such marked redundancy and mobility of the prepyloric mucosa on the muscularis that the mucosa could be drawn down into the duodenum 6 to 7 cm. beyond the pylorus (Fig. 1). The pyloric muscle was greatly hypertrophied, but the lumen of the pylorus was apparently normal, and the mucosa could be passed in and out of it without difficulty. In this case the prolapsed mucosa could be felt through the duodenal wall, but this was not possible in the majority of cases reported in the literature. The rugae of the stomach were continued on to the prolapsed mucosa. Microscopic examination of the resected mucosa revealed hyperemia and many blood cells throughout but no other evidence of inflammatory change. Some observers have found inflammatory infiltration into the mucosa; [2, 8] others have found a narrowing of the pylorus with loss of muscular substance.[4] The presence of ulcers, polyps, and carcinoma on the prolapsed mucosa has been reported.[9, 2] However, none of these findings have been consistently confirmed by most observers.

SYMPTOMATOLOGY. Pain is the most consistent single symptom and may be either aching or cramp-like in character. It is usually felt in the epigastrium, and frequently radiates either under the costal margin or to the back. It may be prostrating. It occurred in four of the six cases presented here. Nausea and vomiting occurred in five of the six cases. Four of the six had sour belches or heartburn. Four of the patients had hematemesis and melena. Variation of the degree of acidity of the stomach does not appear to be distinctive. Anorexia, anemia (which Archer and Cooper[5] believe has not been adequately stressed as a commonly occurring symptom), and loss of weight may be dominant symptoms. Varying degrees of gastric retention, or none at all, may be present.[4] Thus, it can be seen that these patients present a variable group of symptoms similar to those presented by patients with peptic ulcer.

DIAGNOSIS. There is no definite combination of symptoms common to all cases that will allow the diagnosis to be made from clinical observations alone. Roentgenographic examination is essential in arriving at a diagnosis, and fortunately the findings of this examination are distinctive. There is a filling defect in the duodenum, characterized by a central streak of barium showing an intact mucosa.[4] This defect is variable depending on the degree of prolapse of the mucosa and the motor activity of the stomach at the time

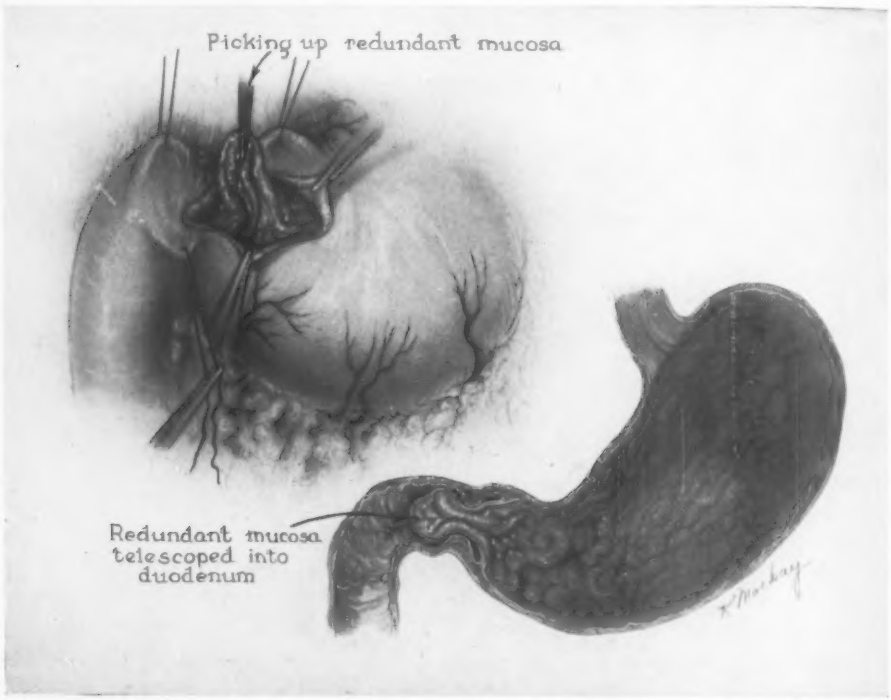

FIG. 2. Case 6: Marked prepyloric deformity with folding out of mucosa into the duodenal cap.

of examination. The mucosa prolapsed into the duodenum allows the barium to flow around it, producing a characteristic mushroom or umbrella effect. Usually the redundant gastric rugae can be traced from the antral canal through the pyloric opening into the base of the duodenal bulb. The rugae in the prepyloric portion of the stomach do not appear abnormal or particularly large.[3] The duodenal bulb is not irritable; it usually retains the barium, thus permitting prolonged examination, a contradistinction to the behavior of the bulb with an active ulcer or duodenitis.[3] Pendergrass and Andrews[6] have summarized the roentgenographic findings as follows:

1. Prolapsing lesions of the gastric mucosa produce a central filling defect in the duodenal cap, and there is a thin shadow of bismuth around the defect.
2. The defect is generally not seen in films made in the erect posture.
3. The diagnosis can be easily overlooked in the fluoroscopic examination.

4. There is no disturbance in the passing of the peristaltic waves.

5. There is always a six-hour residue. (This was not consistently found in the cases observed at Grady Hospital.)

6. There is no defect of the stomach in the presence of pedunculated growths which prolapse through the pyloric ring.

7. There is a variable defect of the prepyloric region of the stomach when prolapsed mucous membrane extends through the pyloric ring.

TREATMENT. The curative treatment of this entity is unquestionably surgical and is directed toward removing the prolapsing mucosa, short circuiting the diseased area, or enlarging the gastric outlet so that the prolapsed mucosa can move back and forth at will without causing obstruction.

Indications for operation are: (1) persistent pain, (2) hemorrhage, and (3) obstruction. Many cases with lesser degrees of prolapse are amenable to dietary management and the administration of antispasmodics. It must be remembered that "the condition is progressive and symptoms become more pronounced as the mucosa becomes more redundant."[4]

Many types of surgical procedures have been used to correct the deformity, including partial gastrectomy, pyloroplasty, gastrojejunostomy, and simple excision of the redundant mucosa. In the one case treated by surgery at Grady Hospital, the redundant mucosa was excised and the appronemated edges were sutured to the muscularis, and a Finney pyloroplasty was done. Probably any procedure that effects removal of the mucosa or gives it freedom to move back and forth without causing obstruction or becoming incarcerated would prove satisfactory.

CASE REPORTS. Summaries of the six cases from the surgical service of Grady Hospital are presented here:

Case 1.—E. W., female, Negro, age 23: This patient was admitted June, 1942, complaining of dull aching pain over the left costal margin, more severe when the stomach was empty, not relieved by taking food. She had eructation of sour material, and on three occasions vomited small quantities of blood, the last episode occurring about one week before admission.

Roentgenographic examination revealed prolapse of the gastric mucosa through the pylorus. There was no evidence of ulcer. She was treated with antiacid powder, belladonna, and a fairly liberal diet eliminating greasy foods. There was no further bleeding, and digestive symptoms were relieved. This patient was last seen in 1944, at which time she stated that she was fairly free from digestive symptoms as long as she remained on the diet.

Case 2.—L. W., male, Negro, age 39: In January, 1939, this patient vomited dark blood, passed dark, tarry stools, had sudden weakness and blind staggers. He came into the hospital three days later and was treated with Sippy diet and Amphojel for three days. After roentgenologic examination, a diagnosis of hypertrophic gastritis with prolapse of the gastric mucosa was made. He was treated symptomatically, the bleeding stopped, and the patient left the hospital against advice. He was readmitted in September, 1939, and July, 1940, each time following an episode of hemorrhage, and each time the patient left the hospital without permission. In February, 1943, he was admitted to the surgical service because of exsanguinating hemorrhage. Transfusions were given and he recovered

from shock. Roentgenographic examination at that time revealed prolapse of the gastric mucosa into the duodenum. The patient refused surgery and left the hospital.

Case 3.—J. A., male, white, age 39: This patient was admitted July 17, 1939, complaining of attacks of epigastric pain, nausea, vomiting, heartburn and indigestion for the previous five years. There was tenderness in the right lower quadrant, and an appendectomy was performed on the day of admission. Pathologic examination showed a normal appendix. Patient left the hospital unimproved. He was readmitted in April, 1945, complaining of having vomited undigested food after meals for a period of ten months. He had never vomited blood. He had had a cholecystectomy at another hospital in January, 1945. Following this operation he had complete relief for three to four weeks, following which he again started vomiting and had almost constant retrosternal pain.

Gastro-intestinal examination showed the pylorus to be somewhat narrowed but the mucosa appeared normal. There was a crescent-shaped filling defect observed in the base of the duodenal cap, representing an hypertrophy of the pylorus and prolapse of the pyloric mucosa into the base of the duodenal cap. Patient left the hospital without permission on April 28, 1945, and was re-admitted in October, 1947, with the same complaints. On a bland diet with belladonna at mealtime he has remained entirely well and has had no further vomiting. This patient had no anemia and vomited no blood at any time.

Case 4.—J. L., male, white, age 70: This patient was admitted May 18, 1944, in a coma following subarachnoid hemorrhage. His blood pressure was 190/120. In addition to other difficulties, he had suffered from substernal pain, heartburn, nausea and vomiting over a period of three years, and had passed tarry stools. Gastro-intestinal examination revealed the folds of mucosa in the pylorus to be very thick and to have herniated into the duodenal cap, indicated by a crescent-shaped filling defect in the base of bulb. There was no evidence of ulcer. The patient was placed on a bland diet with antispasmodics. He has had no further discomfort.

Case 5.—H. W., male, white, age 49: This patient has had digestive disturbances for the past three years. He has been under considerable emotional strain and has had numerous attacks of substernal pain radiating through to the back. These attacks are relieved by opiates and antispasmodics. For about six weeks following an attack, this patient has all the clinical symptoms of peptic ulcer. A physician, he treats himself over this period with a rather strict diet, between meal feedings, and antispasmodics, and apparently entirely recovers. He is then able to eat normally until the next episode of substernal pain and ulcer symptoms. Repeated roentgenographic examinations have never shown a definite ulcer crater, but there is a definite prolapse of gastric mucosa through the pylorus. It is believed that this prolapse occurs periodically, producing the symptoms of ulcer, but whether actual ulceration occurs on this prolapsed mucosa is a matter of speculation.

Case 6.—J. M., male, Negro, age 35: For several years this patient had attacks of abdominal pain beginning in the epigastrium and radiating to the back under the right shoulder blade. These attacks, which lasted two or three hours, were accompanied by heartburn, belching, and occasional vomiting of undigested food. He would take laxatives and recover completely until the next seizure. During an attack July 13, 1947, he vomited about a quart of bright red blood. He continued vomiting until he collapsed. He was admitted to Grady Hospital, July 14, 1947, in a state of shock. His pulse was weak; blood pressure was 80/50; he was sweating and had some air hunger. Hemoglobin was 6.9 Gm.; red blood count was 2 million. He passed several dark, tarry stools. After four transfusions the blood pressure rose to 150/80, hemoglobin to 12 Gm. On July 16, 1947, patient had another episode of bleeding and lost about 1,200 cc. of blood which was replaced by whole blood transfusion. Roentgenographic examination the following day revealed a pronounced prolapse of the gastric mucosa into the duodenal cap, indicated

by an umbrella-like filling defect in the pyloric side of the duodenal cap. (Fig. 2). No other significant changes were noted.

This patient was operated upon August 7, 1947. After the stomach and pylorus were exposed, it was possible to feel the prolapsed mucosa extending for approximately 2.5 cm. into the duodenum. The stomach was opened by a horizontal incision on the anterior surface. The rugae in the prepyloric region of the stomach were very large and were unattached to the muscularis. The mucosa had prolapsed through the pyloric sphincter. With an Allis forcep this loose mucosa could be lifted up in a definite collar-like fold for a distance of 5 or 6 cm. through the incision in the stomach (Fig. 1). The rugae were directed into this collar of mucosa and went on into the duodenum. The collar of mucosa was excised locally and sutured with 00 catgut, taking care to anchor it to the submucous layer. Although the pylorus was patent and appeared normal in size, it was thought wise to transect this muscle. The stomach incision was therefore extended on to the duodenum and a classic Finney pyloroplasty was done. No evidence of ulcer was found. The site of the bleeding was not located. The mucosa was of normal color and appearance.

The patient became ambulatory the following day. Roentgenographic examination showed no evidence of further prolapse, but an enlarged, rather deformed-looking pylorus now exists. The patient had no further symptoms and was discharged from the hospital August 19, 1947. He was last seen November 25, 1947 and had been entirely symptom free since operation.

SUMMARY

1. Prolapse of the gastric mucosa through the pylorus is a distinct clinical entity.

2. This condition occurs rather frequently, being found more often than gastric ulcer. In a review of the last 297 examinations of the upper gastrointestinal tract made at Grady Memorial and Emory University Hospitals, 23 cases were found, an incidence of 7.7 per cent.

3. The diagnosis may be easily missed. This disease may well be the underlying factor in many of the undiagnosed digestive disturbances.

4. The etiology is unknown.

5. The pathology is an abnormal mobility and redundancy of the prepyloric mucosa with prolapse through the pylorus.

6. The symptomatology is not clearly defined.

7. Roentgenographic examination is essential in making the diagnosis. The findings are distinctive.

8. The curative treatment is surgical, but milder cases can be successfully treated by dietary management and antispasmodics.

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DISCUSSION.—DR. T. C. DAVISON, Atlanta, Ga.: I would like to ask what produces the symptoms. Is it obstruction in the pylorus?

DR. IRA A. FERGUSON, Atlanta, Ga. (closing): We thought the symptom of pain was probably produced by spasm of the pyloric sphincter. There is, of course, a question as to whether the prolapsed mucosa becomes strangulated or so incarcerated in the pyloric aperture that it interferes with the blood supply. We think this is a possibility as hemorrhage is a commonplace symptom. However, the most likely cause is pylorospasm.

MESENTERIC VASCULAR OCCLUSION*

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The comprehensive term mesenteric vascular occlusion is usually limited in its application to obstruction of the mesenteric blood vessels by thrombosis or embolism. The condition is very common if we include the thrombosis, usually of minor degree, that occur as part of the picture of gangrenous appendicitis, peritonitis, strangulated hernia, operative trauma, etc. This discussion will be limited to mesenteric vascular occlusion due to thrombosis or embolism resulting from causes other than local infection or injury.

Our interest in this subject has been revived by our recent observation of 11 such cases, which has impressed upon us the facts that the clinical picture is not too difficult to recognize, and that this must be done earlier than it usually is if treatment is to be effective.

We are reporting 19 cases found in the records of Touro Infirmary in the ten year period from 1938 to 1947. Eleven have been observed by one or another of us within the last two years. (See Table I.)

A fairly comprehensive review of the literature combined with our own observations reveals certain facts as to etiology and pathology that are well established.

1. The common statement that the terminal branches of the mesenteric arteries are "functional end arteries"[32] is true only in the sense that they do not have anastomoses between their larger branches. They communicate with each other freely through the profuse submucous plexus.

2. There is considerable variation in the efficiency of this collateral circulation as is shown by the facts that:

a. Experimental ligation of a single terminal artery has little or no effect.[27, 49]

b. Two cases in our series showed focal necrosis and perforation from embolic occlusion of single small arteries. This, no doubt, resulted from progressive thrombosis beyond the site of occlusion which obstructed the collateral channels in the submucosal plexus.

c. Whereas Welch and Mall found that occlusion of the arterial supply of 5-10 cm. of the bowel regularly caused gangrene, Rothschild found that, in dogs, 10-15 cm. could be deprived of its blood supply with survival of the bowel in about half the cases. It has been suggested[12] that vasospasm of the patent collaterals may in some instances account for this variation.

3. Obstruction of an artery proximal to the terminal arcade leaves adequate collaterals except in the case of very large vessels such as the superior or inferior mesenterics.[27, 49, 56] The collateral anastomoses of such arteries are too

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

TABLE I.—*Summary of Findings and End-result of the 19 Reported Cases*

Case	Age	Sex	Pathologic Type	Predisposing Cause	Onset—Duration	Site	Gangrene	Diagnosed	Operation	Result
			Embolic							
1	60	M	Arterial	Embolus from mural Thrombus	Masked	Smaller Vessels Producing Only Mesenteric Infarction	No	No	None	Died
2	40	M	Arterial	Embolus from mural Thrombus	Masked	Superior and Inferior Mesenteric Arteries	Yes	No	None	Died
3	75	M	Arterial	Embolus from mural Thrombus	24 hours	Terminal Ileum, Cecum, and Ascending Colon	Yes	Yes	None	Died
4	57	F	Arterial	Rheumatic Valvular Heart Disease	6 hours	Ileum	Yes	No	Jejunostomy	Died 24 hours p.o.
5	67	F	Arterial	Embolus from Atheromatous Placque-Aorta	3 days	Jejunum, 3½ cm.	Yes	No	None	Died
6	67	M	Arterial	Embolus from mural Thrombus	1. Insidious 5 days 2. Sudden onset	Jejunum, Ileum, Ascending, and Transverse Colon	Yes	No	Resection—Side-to-side Anastomosis	Died
			Thrombotic							
7	57	F	Arterial	Peripheral Arteriosclerosis	48 hours	Entire Small Bowel, Cecum, Ascending Colon	Yes	No	None	Died
8	74	F	Arterial	Peripheral Arteriosclerosis Heart Failure	Masked	Jejunum and Ileum	Yes	No	None	Died
9	75	M	Arterial	Arteriosclerosis Aorta	96 hours	Small Bowel, Cecum, Ascending Colon	Yes	No	None	Died
10	72	F	Arterial	Idiopathic	3 days	Entire Ileum	Yes	Yes	None	Died
11	62	F	Venous	Idiopathic	7 days	Ileum, 3 feet	Yes	Yes	Resec.—end-to-end anastom.	Died 30 days p.o.
12	57	F	Venous	Idiopathic	24 hours	Terminal Ileum	Yes	No	None	Died
13	69	M	Venous	Phlebo-Sclerosis Congestive Heart Failure	6 hour sudden terminal onset	Lower ⅔ Jejunum, Entire Ileum	Yes	No	None	Died
14	26	M	Venous	Disseminated Lupus Erythematosis	8 days	Jejunum and Ileum	Yes	Yes	Died on Op. Table prior to incision	Died
15	45	M	Venous	Portal Hypertension	1. 36 hours 2. 36 hours	1. Ileum 2. 3 feet	Yes	Yes	Resec.—side-to-side anastom.	Died 8 days p.o.
16	48	M	Arterial & Venous	Idiopathic	3 weeks	Ileum, 12 feet	Yes	Yes	Resec.—end-to-end anastom.	Recovered
17	58	M	Arterial & Venous	Intestinal Lipodystrophy (Whipple's Disease)	72 hours	Ileum, 1½ feet	Yes	Yes	Resec.—end-to-end anastom.	Died 2 days p.o.
18	30	M	Arterial & Venous	Idiopathic	6 days	Terminal Thrombosis	No	No	Enterostomy	Died 1 day p.o.
19	62	M	Arterial & Venous	Idiopathic	3 days	Distal Ileum	Yes	No	Ileostomy	Died 2 days p.o.

small and too widely separated to provide adequate blood supply for so long a segment of bowel.

4. Gradual occlusion of any artery, even the superior mesenteric, may be well tolerated; in fact, if it is very slow, no recognizable symptoms may occur.[50, 53]

5. Partial occlusion, sudden or gradual, of the arterial supply of any segment of bowel, whatever its length, may cause only minor disturbances of function. However, such a partial occlusion that has been well tolerated when the general circulation was good, may cause infarction when at a later date the

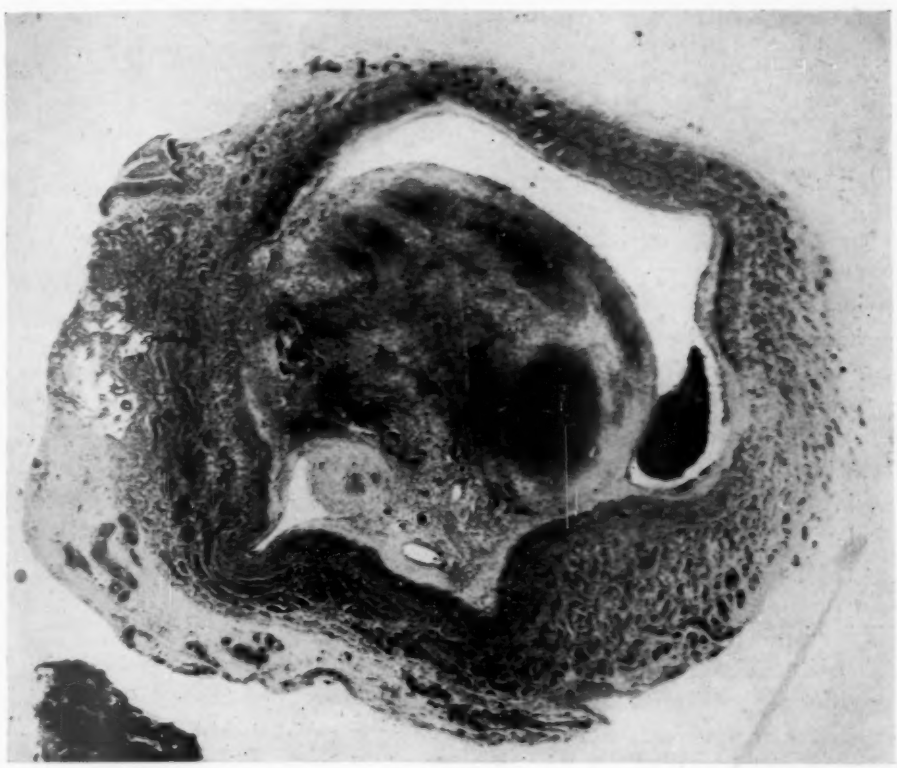

FIG. 1.—Subtotal occlusion, mesenteric vein, old. Increased portal pressure due to cirrhosis of liver and possible heart failure superimposed on the portal occlusion produced complete occlusion of mesenteric veins and gangrene. X-18.

efficiency of the general circulation is impaired.[7] Welch and Mall observed experimentally that when all collaterals to a segment of bowel were ligated and the mesenteric artery gradually occluded, infarction took place when the pressure distal to the occlusion fell to ⅕ of normal. Two of our cases showed this phenomenon and in addition one showed the same effects from partial occlusion of the superior mesenteric vein. (Fig. 1.)

6. Simultaneous thrombosis of both arteries and veins is probably rare but involvement of either is often followed by thrombosis of the other, and it is usually difficult or impossible for the pathologist to determine the site of the

beginning of the process. Donaldson and Stout[8] have shown experimentally that spread of thrombosis from veins to arteries does not always occur. Five of our cases gave histologic confirmation of this observation and four show that the converse is also true.

7. All infarcts of the intestine are hemorrhagic.[55] Why arterial occlusion causes hemorrhagic infarction is not entirely clear. It may be due to reflux of blood from the veins actuated by the positive portal pressure[15] or to the flow of arterial blood into the submucous plexus from anastomosing arteries.[56] It is difficult to see how the latter explanations can apply to infarcts resulting from occlusion of major arteries because of the great length of bowel intervening between the patent collaterals.

8. The pathologic and physiologic changes caused by mesenteric vascular occlusion are the same in arterial, venous, and combined involvement. Depending upon the degree of ischemia produced, the effect upon the bowel may be (1) none, (2) paralytic ileus without pathologic change other than congestion, (3) ulceration of the mucosa, (4) ecchymoses into the bowel wall, (5) hemorrhagic infarction, focal or massive, and (6) finally, perforation. When the process progresses as far as ulceration, blood is usually extravasated into the lumen. When infarction takes place, there is extensive hemorrhage into the lumen of the bowel, edema and hemorrhagic infiltration of the mesentery, and transudation of fluid, usually bloody, into the peritoneal cavity.

9. As a rule, little or no gas accumulates in the involved, segment, presumably due to the fact that the infiltrated intestinal wall is not readily distensible. Chesterman,[3] from observations on cats, concluded that distention is prevented in the earlier stages by tonic contraction of the involved bowel.

In one of our cases, although there was extensive gangrene, there was only slight distention of the small bowel, despite roentgen-ray evidence of a few fluid levels.

10. When ischemia of a segment of bowel takes place, hyperperistalsis occurs for a period reported to be as long as two to three hours.[45, 56] This is followed, after a variable time, by paralytic ileus, which has the effect of producing partial intestinal obstruction with all of its associated phenomena.[23] At any time before gangrene develops, the process may be arrested and complete recovery takes place. This is probably a common event in minor degrees of thrombosis.[8] We have previously observed this phenomenon and the histological examination of the autopsy specimen in one of our cases shows old recanalized thrombi as evidence of two previous similar episodes. (Fig. 2.) Recurrence of mesenteric vascular occlusion is especially likely in portal hypertension and in mesenteric arteriosclerosis.[5, 11]

HISTORICAL

The first case was reported by Tiedemann[50] a little over one hundred years ago. Virchow[53] four years later in 1847 described the pathology. The clinical picture received scant attention until Litten's[32] paper in 1875. Councilman[7] in

1895 commented on the tendency of rare pathological conditions to occur in groups and detailed the autopsy findings in three cases of superior mesenteric occlusion seen in a two-week period.

Elliott[14] could find only three surgically treated cases prior to 1895, all unsuccessful. He reported two cases seen within a fortnight. The first was a 24-year-old male, in whom it was necessary to resect four feet of gangrenous jejunum. The open ends of the intestine were stitched into the abdominal wall,

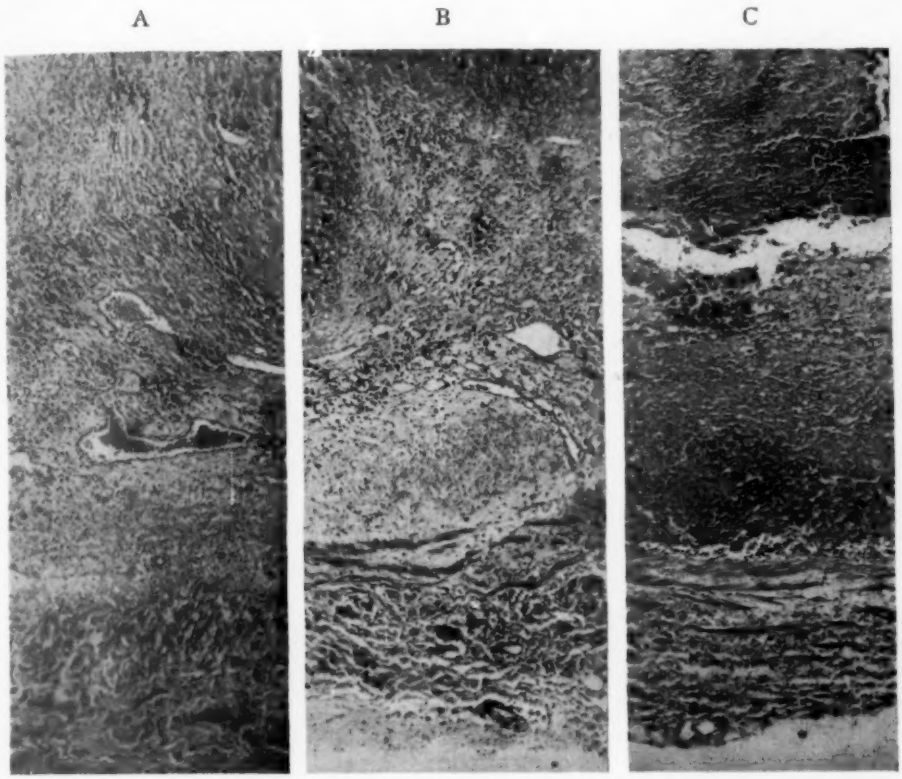

FIG. 2.—Progressive phases of thrombosis, organization, and recanalization. Section (a) old, (b) intermediate, and (c) recent. X-60.

and closure was performed two weeks later. This was the first successfully treated case.

Welch and Mall,[56] in 1899, reported their results on experimental mesenteric vascular occlusion in dogs. In 1904 Jackson, Porter, and Quinby[24] made the first comprehensive survey of the literature, collecting 184 cases and adding 30 new ones obtained from various hospitals in Boston. Trotter[51] in 1913 added six new cases of mesenteric thrombosis and collected in monographic form a total of 360 cases from the literature. He tabulated a mortality rate of 94 per cent, and a correct preoperative diagnosis in only four per cent of all cases.

Ross Loop[34] in 1921 reviewed in detail nine personal cases seen over a two-year period, which he declared presented a pathologic picture so char-

acteristic as to be unmistakable and a syndrome so uniform that it suggested a definite disease entity. His description of the gross pathology and symptomatology is by far the most vivid yet written. The same year Klein[27] made an extensive survey of the literature concerning the experimental work on mesenteric thrombosis.

Cokkinis[4] published a monograph in 1926 and reported on experiments in which he found that the arterial collateral circulation was considerable, and that the venous was of even greater volume.

Jerauld[25] successfully resected 19 feet of intestine for thrombosis of the superior mesenteric artery in 1929. Recently, H. W. Meyer[37] described the amazing case of a 20 year old soldier, operated on in a field hospital, in whom it was necessary to resect all but 20 inches of the small intestine, and the right half of the colon for occlusion of the superior mesenteric artery, with complete recovery. This is a slightly more extensive resection than that reported by

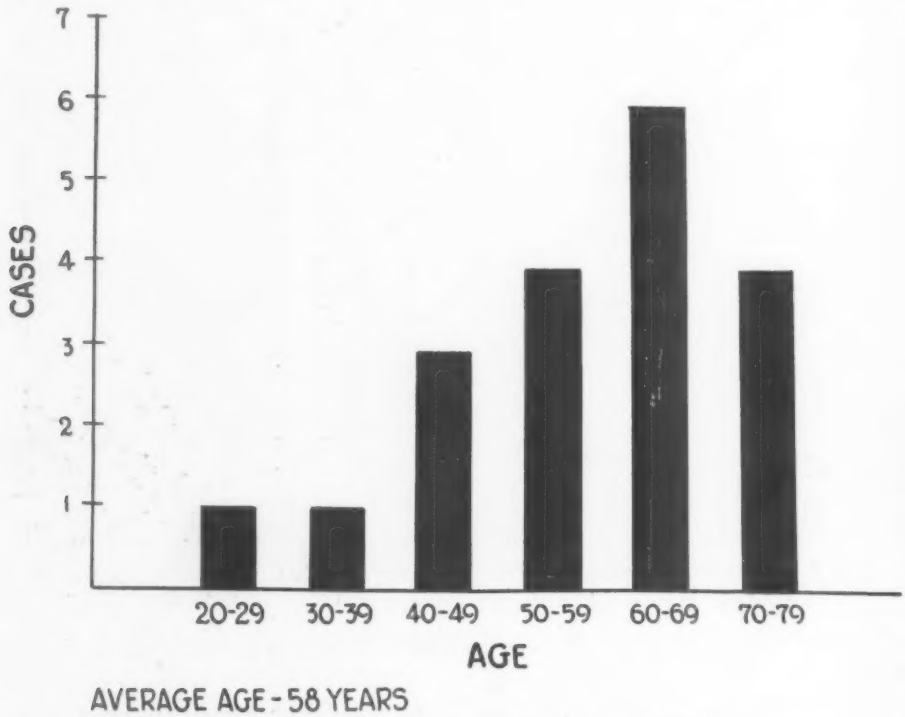

FIG. 3.—Incidence of occurrence grouped in decades.

Madding and McIntire.[36] Grey Turner[52] in 1937 reported a case in which he successfully performed a caesarian section and resected 10 feet of small bowel. That these extensive resections are feasible was shown experimentally on dogs by Flint[18] in 1912.

INCIDENCE

"Primary" mesenteric vascular occlusion is a very uncommon disease, occurring in from .02 per cent[54] to .105 per cent[31] of all surgical admissions. The

incidence at Touro Infirmary from 1938 to 1947 was 19 cases in 55,232 surgical admissions, .038 per cent. It should be noted that, in most collections, cases due to local trauma and infection are included.

The disease is about twice as common in men as in women.[24, 30, 31] In our series the proportion was 13 to 6. It occurs most often in the third to the sixth decade. In our own series the average age was 58 (Fig. 3), as compared to those of Brady,[2] 44 years, Larson,[30] 55.2 years, and Whittaker and Pemberton,[58] 43 to 45 years. However, it may occur in children, as one of us has previously observed, and as has been reported by several authors.[26] A number of cases have been observed in infants, the youngest being one month old.[26, 29, 43, 20]

ETIOLOGY (Fig. 4.)

Arterial mesenteric occlusion may be either embolic or thrombotic, the former being more common (6 to 4 in this series).

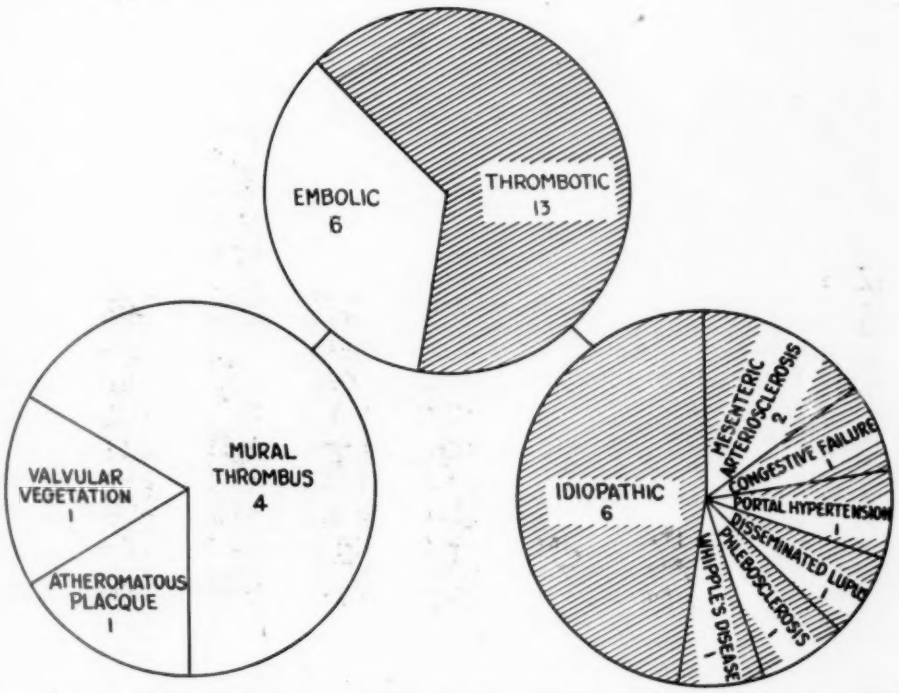

FIG. 4.—Etiologic factors responsible for the embolic and thrombotic groups. The thrombotic group comprises arterial, venous, and combined categories.

The *emboli* may originate in the heart, the aorta, or the pulmonary veins.[53] They may be fragments of thrombi, of aortic plaques, or of vegetations from the heart valves. Mural thrombi occurring in coronary occlusion and free clots formed in the heart chambers during severe arrythmias or congestive heart failure are the most common sources. Such emboli are often large, and not infrequently block the superior mesenteric artery or one of its major branches (Fig. 5). Emboli from vegetations on the heart valves, on the other hand, are

usually small and often multiple. Numerous infarcts in other organs are frequently associated with either type.

Arterial thrombosis may result from diseases of the vessel walls, from infarction of the bowel due to venous occlusion, perhaps from alterations in the clotting mechanisms, and probably other causes. Among the vascular diseases reported to have caused it are Buerger's disease,[22] Raynaud's disease,[3c] and mesenteric arteriosclerosis.[5] Our series includes two cases of thrombotic occlusion of the superior mesenteric artery and one of a large branch of the same vessel, all due to advanced arteriosclerosis.

FIG. 5.—Embolus lodged in superior mesenteric artery.

Venous occlusion is probably always due to thrombosis and its most common causes are infection and trauma, but these were excluded from this discussion, when the cause was apparent. This leaves as the usual causes of so-called primary venous thrombosis diseases of the vessel walls, slowing of the venous flow, damage to the vessel walls incident to arterial occlusion, and perhaps alterations in the clotting mechanism. Portal hypertension, due to cirrhosis of the liver, cavernomatous transformations of the portal vein, or congestive heart failure, is among the most common demonstrable causes. The vascular diseases, other than arteriosclerosis, that cause arterial occlusion may also cause venous thrombosis. To this group we add a case of disseminated lupus erythematosus which seems to be unique. It seems odd that whereas the vascular changes of this disease involve both arteries and veins, our pathologist found only venous thrombosis.

Combined arterial and venous thrombosis of the peripheral vessels is also a common type of mesenteric vascular occlusion. It seems probable that the process starts as a venous thrombosis in most instances and that the arteries are thrombosed secondarily, because patent arteries are frequently encountered in the involved area. The pathologist usually cannot determine where the process began. However, simultaneous arterial and venous thrombosis may occur in such diseases as thrombo-angiitis obliterans.

Most instances of mesenteric *thrombosis* can be explained on the basis of one or another of the above mentioned causes but there remains a considerable number that must be listed as idiopathic. Even though we have excluded all cases in which infection of the intestinal wall was demonstrable, it seems probable that the "idiopathic" cases are due to some pathologic process in the bowel.

We have included one example due to Whipple's intestinal lipodystrophy[57] which seems to be unique.

CLINICAL PICTURE

Whereas it is possible to classify most cases etiologically as arterial or venous, and as embolic or thrombotic, this is often impossible, clinically. There are only two distinct clinical types. The first is produced by sudden blockage of a major mesenteric artery and the second by any of the other forms of occlusion. The difference in behavior of these two groups is due to the fact that the former causes sudden complete infarction, whereas the latter causes a gradually increasing ischemia that may either subside or progress to complete infarction. Our collection includes seven of the first type and 12 of the second.

When the stage of infarction is reached, the picture is the same, no matter how it has developed,[47] and since all except two of the cases here reported had reached this stage no differentiation as to type was possible except on the bases of the history of a causative disease and the character of the onset.

Since sudden occlusion of a major artery is almost always due to advanced cardiovascular disease, there is usually a recent history of such a condition, but occasionally it may be overlooked as in two cases of this series, and in the remarkable instance reported by H. W. Meyer.[37] Typically, individuals suffering from severe cardiac disease exhibit a dramatic transformation to the picture of a major abdominal catastrophe characterized by sudden severe abdominal pain, usually cramplike, severe nausea and vomiting, and profound shock. All signs of peristalsis soon disappear and, since these unfortunates usuauly die before peritonitis develops, rigidity is seldom seen. The temperature may be subnormal to slightly elevated. Leucocytosis, moderate to very high, is usually found. This striking onset is unfortunately frequently masked by the severity of the cardiovascular state, as we have twice observed.

The gradual development of intestinal ischemia that results from all other types of occlusion usually passes through three stages. First, a period of variable length, characterized by uncoordinated hyperperistalsis with colicky pains and nausea not unlike that following overindulgence in green apples; second, a period of intestinal paresis that produces the picture of partial intestinal obstruction; and, third, a period of intestinal strangulation with all of its consequences. The clinical state of the patient when first observed depends largely upon the stage of the pathological process, so that one must depend largely upon the history for diagnostic data. Histories taken by first year interns frequently cannot be depended upon for such data, so we have, to some degree, drawn upon our personal observations, as well as on the literature, to fill out the picture.

The prodromal period is characterized by: (1) inconstant nagging abdominal pain, usually colicky, and located vaguely about the mid-abdomen; (2) nausea and vomiting, usually mild and frequently subsiding after a short time; (3) constipation or diarrhea; (4) moderate distention without rigidity. The picture changes gradually into one of intestinal obstruction with aggravation

of ali features except diarrhea. Leucocytosis develops and is often very high. Peristalsis, which has been hyperactive, rapidly subsides. At any stage, up to and including this, spontaneous recovery may take place[9] as one of us has observed twice previously, and as we suspect from the histories of two of the cases here reported. If recovery does not take place, the classical picture of intestinal strangulation develops, either gradually or with such dramatic suddenness that the prodromal period may be forgotten by both patient and family, and can be recalled only by persistent questioning.

A more detailed discussion of individual symptoms and signs follow: (Fig. 6.)

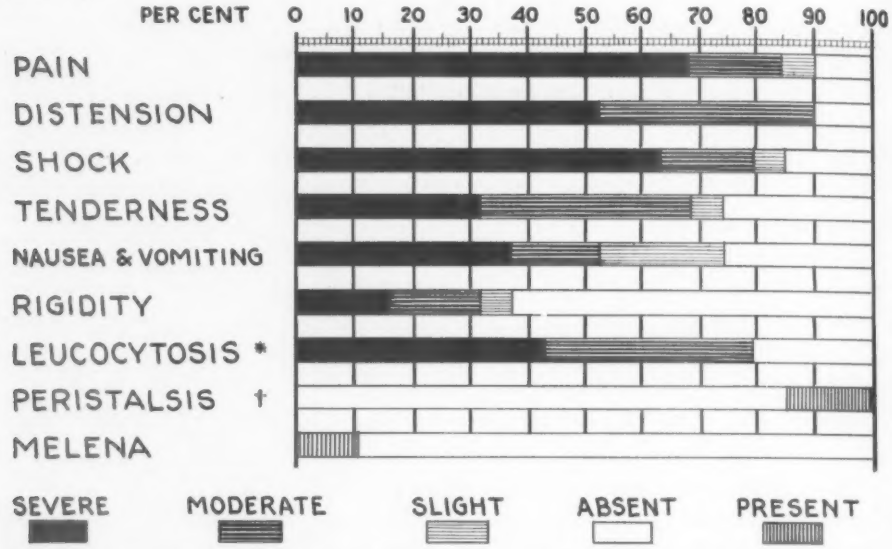

FIG. 6.—Pertinent clinical findings, tabulated in order of occurrence. *W.B.C. not done in 5 cases. 10-19 thousand—Moderate Over 20,000 = Severe. †Recorded in 7 cases only.

1. Pain is a constant symptom,[13, 14] being present in all patients whose state of consciousness permits its perception. At the onset it is often colicky and of mild to moderate severity, but later it usually becomes constant and very severe. In sudden occlusion of major arteries, it is severe from the onset if perceived at all. It is usually located vaguely about the mid- or lower abdomen, and there is no radiation. In our series it was severe in 13 cases, moderate in three, slight in one, and masked by a terminal cardiovascular state in two.

2. Tenderness is less constant but is distributed as is the pain. It is usually not severe until peritonitis develops. In our series it was severe in six, moderate in seven, slight in one, and absent in five.

3. Rigidity does not occur until peritonitis develops, and in extremely ill patients may not be found even then.[11, 8]

4. Distention develops gradually and is marked only in the late stages of the process.[24] In this series it was marked in ten, moderate in seven, and absent in two. It is interesting that the last mentioned two were cases of massive arterial occlusion. Perhaps death occurred so soon after this developed that there was insufficient time for the development of distention.

5. Shock is present at the onset only in sudden massive infarction but develops in almost all if not all cases where extensive gangrene occurs.[17] It was present therefore in most of our cases (16), before operation or death. It was reported as severe in 12, moderate in three, mild in one, and absent in three.

It was usually impossible to relieve the shock in these patients, even though large amounts of blood and other fluids were given.

6. Nausea and vomiting are common but not usually severe. They were severe in seven cases, moderate in seven, and absent in five of our series.

Hematemesis is said to be common[14] but it occurred in only one of the cases here reported, and in that one it was due to esophageal varices in a case of portal hypertension and occurred before the onset of the mesenteric thrombosis.

7. Peristalsis is undoubtedly active at the onset but it usually ceases early, so was often absent at the time of admission to the hospital. No mention was made of it in 12 of our cases, which we consider a shameful neglect of a valuable diagnostic aid. No doubt this examination was made more often and not recorded as we are sure was the case in two or our own patients. In the seven cases in which auscultation of the abdomen was mentioned, peristalsis was heard in only one.

8. Melena is said to be frequent and of great diagnostic importance,[1, 24, 41, 58] but it occurred in only two of our cases, and in one of these it occurred before the onset of the thrombosis and from another cause. In view of the fact that gangrenous bowel always contains blood, it is surprising that melena was so infrequent. When observed, it must be considered an important diagnostic sign, and a rectal examination should be made in all suspected cases.

9. *Temperature.* Subnormal temperature has been noted by several observers[8, 14, 34] but was not a feature of the cases here reported. In those without gross evidence of peritonitis the temperature averaged from 99 to 101.

10. *Leucocytosis.* Unlike other types of intestinal obstruction, that caused by mesenteric vascular occlusion usually causes a high leucocytosis. In eleven of our cases it ranged from 14,000 to 30,000 total leucocytes, and from 85 per cent to 95 per cent polymorphonuclears. In five there was no record of a blood count, and in three normal values were observed. A high leucocytosis when found is a valuable point in differential diagnosis.[17]

11. After gangrene has developed, an indefinite doughy mass is often palpable. This has frequently been reported,[14, 27] and we have ourselves observed it in four of our own cases, all of which are included in this series. Since such a mass was noted in the record of only three cases, we are confirmed in our belief that others beside ourselves have been negligent in recording all of their find-

ings. In one of our personal cases, the mass was felt only after a spinal anesthetic was administered, and was a valuable finding in determining the site of the incision.

12. Constipation is the rule after the onset of the obstructive phase of the disease, but bloody diarrhea has been reported.[8, 14] Only four of our cases had a history of recent diarrhea and only two had diarrhea after hospitalization. One of the latter was the case of Whipple's disease, in which diarrhea is a constant symptom.

13. Jaundice has not previously been reported. In this series it occurred in four, three of which were our own. One survived, so the cause could not be determined, but he showed evidence of hepatitis, including a 2+ cephalin flocculation, a direct Van den Bergh reaction, and an icterus index of 100; one had marked cirrhosis of the liver; and one showed at autopsy severe fatty metamorphosis, and central lobular degeneration of the liver cells. The jaundice was hepatogenous in type in all four and one may speculate as to whether hepatitis contributed to the causation of the thrombosis or whether it resulted from the absorption of toxic products from the gangrenous bowel.

14. *Roentgen-ray Findings.*—Roentgen-ray examination of the abdomen was made in only nine cases, in two of which a tentative diagnosis of mesenteric thrombosis was made by Dr. Meyer Teitelbaum, who has since reviewed all of the films and compared them with his special file on intestinal obstruction. He states that, "Analysis of the films of these patients indicates that in no case were they absolutely normal. The deviations do not, however, follow any fixed pattern nor can they be correlated with the nature, site, extent, or duration of the vascular occlusion in such fashion as to permit a definite preoperative diagnosis." Having thus satisfied his craving for meticulous accuracy, he makes it clear that (1) ileus of varying grade was present in all cases, (2) the colon, contrary to what is usually seen in mechanical obstruction, usually contained a normal amount of feces and gas; and (3) while one group showed findings similar to those seen in gastroenteritis or in partial obstruction, the other simulates mechanical obstruction, especially with strangulation and peritonitis. Such findings, while admittedly not diagnostic, should urge the surgeon toward early exploration.

DIAGNOSIS

The diagnosis of this disease can usually be made or suspected if it is given consideration. When an acute abdominal crisis is encountered, several points should direct attention to it.

1. A history or physical findings of any of the before-mentioned predisposing causes.

2. The character of the onset, which is in general of two types:

a. A sudden transformation from a picture of advanced cardiovascular disease to one of an acute abdominal catastrophe.

b. A gradual transition from a mild "colic", with or without diarrhea,

to a picture of partial intestinal obstruction, and finally to one of intestinal strangulation.

3. The early diminution or disappearance of peristalsis in a case in which, after due consideration of the common causes of "the acute abdomen", intestinal obstruction seems the most probable one.

4. The appearance of a high leucocytosis in such a case before peritonitis develops.

5. Roentgen-ray evidence of ileus without evidence of evacuation of the colon or, as sometimes occurs, with diffuse dilatation of the entire small bowel and the right half[46] or all of the colon. We also feel that roentgen-ray evidence of free fluid in the peritoneal cavity before peritonitis develops is a significant sign.

6. Bloody stools or blood in the rectum if not otherwise accounted for.

OPERATIVE FINDINGS

A proper evaluation of the evidence will usually lead to exploration if the condition of the patient permits. Even then the diagnosis may be missed in the early stages, as we believe occurred in two cases in this series, if one fails to bear in mind the gross pathologic picture so graphically described by Loop.

When the abdomen[15] is opened, a copious amount of peritoneal fluid escapes. It is transparent, sticky, amber, or, more often, blood-tinged, odorless, and without coagulated lymph. All visible intestine may appear normal, though slightly distended. The diseased portion may be entirely overlooked unless sought for deep in the pelvis. The cyanosed, plum-colored, soggy, edematous intestine with glistening peritoneum free from exudate or adhesions, its lumen relaxed but not greatly distended, lies inert within the abdominal cavity, held down by the weight of the fluid within its lumen. It contains litle gas. The mesentery is a thick doughy mass dragging down over the brim of the pelvis as though adherent. Thrombosed vessels may often be seen and felt. This description taken almost verbatim from Loop applies to the stage before gangrene has developed. From earlier experience we can confirm it and add the observation that the bowel distal to the involved segment is usually as much distended as is that proximal to it. This is also true after complete infarcation. It is evident that the paralytic ileus extends both proximal and distal to the ischemic segment.

Our recent experience includes no early cases. Late in the disease when the abdomen is opened, a large amount of turbid, bloody, fetid fluid escapes. The involved bowel now lies in the abdominal cavity proper, presumably having been dragged up from the pelvis by the shortening of the mesentery that results from edema and hemorrhagic infiltration. It is plum to chocolate-colored, with a greenish iridescent sheen, and lies heavily deep in the cavity. If the gangrenous segment is small, it may be completely covered by flaccid distended loops of viable bowel, but if it is extensive, it may fill the entire field—an appalling sight. Small wonder that many such cases have been

abandoned as hopeless. A well-marked line of demarcation may be seen occasionally, but usually there is a slow gradation from black to purple to red to pink. The bowel is rounded but not usually greatly distended. It contains much bloody fluid but little gas, presumably because the thick leathery wall resists distention. On one previous occasion we have seen a markedly distended bowel in a case of sudden massive occlusion of the superior mesenteric artery. In this instance the infarction had been so abrupt that the infiltration was minimal.

The mesentery is thickened, edematous, and hemorrhagic. The major vessels may be felt as thick cords, but are difficult to see. The small veins stand out as reddish black lines in the pale yellow, red-splotched mesentery. When clamps are applied, they cut through the swollen tissue as if it were oily cheese and black worm-like clots are extruded from the vessels.

Very late in the disease, if the patient survives long enough, peritonitis develops; whether or not perforation occurs.

PROGNOSIS

Although the fourth case of mesenteric vascular occlusion reported to have been operated upon for this disease recovered,[14] 24 successful resections had been reported by 1921,[27] and a recovery rate of 68% following surgery was estimated by J. Meyer[38] in 1931, results are actually still very poor. The mortality reported by Meyer comes from a survey of the literature which abounds in successful case reports, and such reports are notoriously misleading. Larger consecutive series are more dependable. Whitaker and Pemberton record a mortality rate of 84% in 19 operative cases. One of these cases was a volvulus which does not properly belong in this category. Douglas[10] had four recoveries in 11 patients he operated on, and Moore four in eight operated upon. We report only one recovery in 19 cases, but only eight were operated on. (Table I.)

TREATMENT

The mortality in our series is so high that it does not seem to encourage surgical treatment but there are several factors that favor some degree of optimism.

1. Seven of these patients were practically moribund from cardiovascular disease when the mesenteric occlusion occurred as a terminal event. They were, of course, hopeless and should not influence our opinion as to the value of surgery in patients who are in reasonably good general condition.

2. The most extensive resection in this series (Fig. 7) and numerous similar or more extensive ones reported have been successful. Among these the amazing cases of Meyer and of Madding and McIntire, each of whom resected all of the small bowel, except two to four feet, and the right half of the colon, and that of Grey-Turner, who resected ten feet of small bowel and performed a Caesarian section at the same time, are notable. It is evident that if the patient is otherwise reasonably sound, resection is worth trying no matter how extensive the lesion.

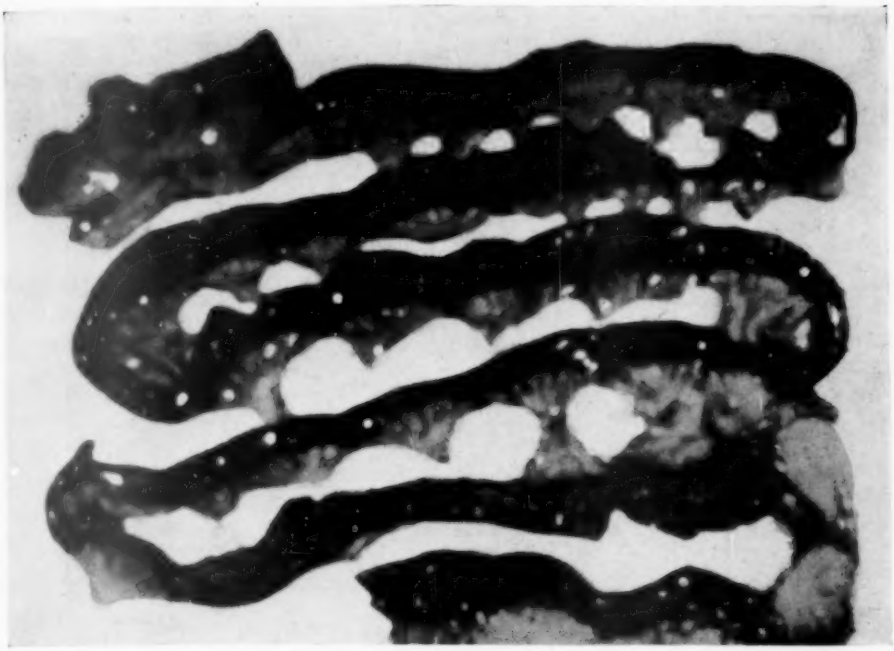

FIG. 7.—A. Massive gangrene of jejunum and ileum. Twelve feet resected with survival of patient.

3. Many surgeons, including ourselves, have formerly believed that mesenteric thrombosis was almost inevitably progressive and would therefore spread to involve the anastomosis if resection were done. Many case reports and our own experience show that this is not true. Three of our cases survived the operation for eight or more days. The anastomosis healed and functioned in all three. One developed another area of thrombosis with gangrene but at a distance from the site of the anastomosis.

Due to the early experience of one of us (J.D.R.) with three cases of mesenteric thrombosis, short of infarction, that were treated by enterostomy, with two recoveries, and to the high mortality of resection, we had formerly believed that such cases were best treated conservatively, a view expressed by Ross.[48] We now believe that this is a dangerous practice, for most of such cases will probably progress to gangrene if the ischemic segment is not removed with a liberal margin of normal bowel. If resection is done at this stage, the mortality should be quite low.

The use of anticoagulants has not yet had a fair trial in this disease. A few successes have been reported,[19, 42, 35] but not enough to be of real significance. Theoretically, they should be of great value in both prevention and treatment. (1) The formation of clots in the heart may be prevented, thus lessening the danger of embolism to the mesenteric as well as to other vessels;[40] (2) mesenteric thrombosis short of infarction may be arrested before fatal ischemia develops; and (3) the spread or recurrence of mesenteric

FIG. 7.—B. Contrast study of gastro-intestinal tract done three and one-half weeks after operation.

thrombosis after resection may be prevented.[33] Our own experience has been somewhat discouraging. Three of our patients survived long enough to permit a trial. One had recently suffered massive hemorrhage from esophageal varices, so we dared not use anticoagulants. Heparin was tried in the other two, but one developed melena of severe grade on two occasions, and the other bled into and around the operative wound. Perhaps our control of clotting time was not accurate. Certainly we believe that anticoagulants have value and should have a thorough trial, but wide resection of the diseased bowel is necessary when infarction has occurred, and we believe that it is desirable in all cases suitable for operation.

CONCLUSIONS

1. The mortality of mesenteric vascular occlusion is extremely high because: (a) many patients are in extremis from cardiovascular disease when it

occurs and (b) in most others diagnosis and treatment are too long delayed. The first cause is unavoidable, but the second frequently is not.

2. Pathologically, mesenteric vascular occlusion can be classified as embolic or thrombotic and as arterial, venous, or combined, but no such differentiation can be made clinically. Sudden complete occlusion of major mesenteric vessels produces a recognizably different picture, but all other mechanisms produce essentially the same syndrome.

3. Features that aid in diagnosis are: (a) a history of a known predisposing cause; (b) the character of the onset; (c) the early disappearance of peristalsis in a case of suspected intestinal obstruction; (d) the occurrence of a high leucocytosis; in such a case without evidence of peritonitis; (e) the development of shock when all other evidence points toward partial obstruction.

4. The treatment for all types of the disease should be the same because the effect on the bowel is the same and the ischemia usually progresses to infarction. Radical resection of the bowel is essential when gangrene has developed, and is, we believe, advisable in all cases. Anticoagulant therapy may prevent mesenteric vascular occlusion and may be of value in postoperative treatment, but cannot, at this time, be recommended as definitive treatment.

NOTE.—We would like to express our appreciation of the invaluable assistance of Dr. Harvey Colvin, Head of the Department of Pathology at Touro Infirmary, and of Dr. Meyer Teitelbaum, Head of the Touro Infirmary's Department of Radiology. Dr. Colvin made a complete review of all the pathologic material in this series, and his interpretations formed the basis of our analysis. Dr. Teitelbaum compared all the roentgenograms with his special file on intestinal obstruction and made a searching analysis of them for us.

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DISCUSSION.—DR. L. H. STRUG, New Orleans: I would like to take this opportunity to show some interesting features of several of our cases. (slides)

The first slide shows a schematic drawing of the small and large bowel, showing the approximate amount of small bowel involved in the infarction and extent of resection. Eleven feet of jejunum and ileum were involved as a result of the mesenteric thrombosis, and twelve feet of small bowel was resected, with survival. The next slide shows the gangrenous bowel, with the gradation on each end to normal appearing bowel.

The next slide is taken from a gastro-intestinal x-ray series which was done approximately four weeks following surgery, and shows the remaining small bowel, which is estimated to be between four and six feet in length.

The next slide is from our case of mesenteric thrombosis, in which intestinal lipodystrophy (Whipple's disease) is held to be the causative factor. This slide shows the greatly magnified intestinal villi, which is considerably enlarged due to numerous fat deposits and large number of foam cells, characteristic of this disease. Next is another microscopic section showing extrinsic compression of a venule by the large foam cells and fat deposits.

This slide is from our case of disseminated lupus erythematosus, which shows the characteristic hyaline degeneration of the wall of the arterioles. This section is taken from the stomach wall. Next is shown typical arteriolar involvement in the periadrenal vessels. The next slide, from a section of the intestinal wall, shows normal mucosa, ulceration and involvement of the venules with thrombosis. The occurrence of this pathologic process in the stomach and small bowel is unusual.

The next two slides are from a case which Dr. Lucian Landry kindly allowed us to use in our series. The first is a schematic drawing of the large and small bowel, which attempts to depict the three episodes of mesenteric vascular occlusion, with the terminal one resulting in infarction, perforation, peritonitis and death. The second slide shows the three episodes of mesenteric venous occlusion. The oldest and first episode is to your right, showing a venous thrombosis, which is old, and organized, with some evidence of

recanalization; the middle section shows a somewhat more recent venous thrombosis, with some organization, and the one to the far left shows an extremely recent venous thrombosis, with a laminated thrombus and no organization whatsoever.

The final slide is a table showing the extent of involvement of our 19 cases, one case having infarction in the mesentery alone, two having perforation and peritonitis with minimal infarction, and the extent of resection in the four cases in which this was done.

DR. JAMES D. RIVES, New Orleans (closing): The cases we have reported did not include an example of mesenteric thrombosis due to a blood dyscrasia, nor have we found an authentic case in the literature. Dr. George Curtis has just reported to me a case following splenectomy for thrombocytopenic purpura. It is probable that it is a case of thrombosis of the superior mesenteric vein resulting from the tremendous increase in platelets that commonly follow splenectomy for throbcytopenic purpura. However, it must be remembered that thrombosis of the splenic vein frequently occurs following splenectomy and that it may spread to involve the portal and mesenteric veins. Doctor Curtis' case may therefore have been the result of the splenectomy rather than of purpura *per se*.

LYMPHANGIOMA OF THE MESENTERY*

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Benign tumors of the mesentery occur rarely and lymphangiomas in this location are especially unusual. According to Braquehaye's[1] account, Benevieni, in 1507, was the first to observe a cystic tumor of the mesentery, and Carson,[2] in 1890, made the first American report of a chyle cyst of the mesentery. Gerster[3] wrote in 1939, there were approximately 500 cases of chyle cysts reported in the literature. Murback, Lewison and Diebert[4] stated that the great majority of the reported abdominal lymphangiomas have involved the omentum and that the retroperitoneal and mesenteric types have occurred much less frequently.

A lymphangioma is usually described as a neoplasm consisting largely of endothelial lined spaces containing lymph. Wegner's[5] original classification of lymphangiomas is generally accepted although transition types are sometimes seen.

SIMPLE LYMPHANGIOMA

A circumscribed swelling composed of dilated lymph vessels in a very cellular connective tissue stroma. This type is usually seen in infants and children, involving the skin and subcutaneous tissues of the face and neck.

CAVERNOUS LYMPHANGIOMA

A spongy tumor, composed of dilated lymph vessels, in an actively growing lymphoid stroma. This form is seen more often about the face, tongue, neck, mesentery and the retroperitoneal regions.

CYSTIC LYMPHANGIOMA

Cystic lymph spaces, usually endothelial lined, in a lymphoid stroma. Cystic lymphangiomas may be seen in the neck, the supra or infraclavicular regions, the axillae, the retroperitoneal space, the mesentery and the inguinal regions.

ETIOLOGY

Most writers favor the opinion that lymphangiomas arise from embryonic rests of lymphatic tissue. As pointed out by Singleton,[6] wherever these centers exist congenitally, such tumors are possible. This is substantiated by the preponderance of the tumors in the region of the jugular, subclavian, axillary, iliac, femoral and mesenteric lymph sacs.

Several investigators felt that lymph stasis following chronic lymphadenitis might be an important factor in the etiology of lymphangiomas. However, Ewing[7] was able to demonstrate free communication between the afferent and

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

efferent lymph vessels in several lymphangiomas and concluded that stasis could not have been an important etiologic factor.

SYMPTOMS

The tumor may be asymptomatic and incidentally found at the time of an abdominal operation or at necropsy. If the lesion is large enough, the patient may notice an abdominal tumor, or there may be a feeling of tension due to increase in the size of the abdomen. Occasionally a patient complains of abdominal pain which is usually intermittent, aching, dull, and rather constant in position.

DIAGNOSIS

An exact diagnosis is frequently impossible but careful physical examination and roentgenographic studies may inform the examiner that the adjacent viscera are normal and assist in the localization of the tumor. If the mass is on the right side, one must exclude enlargements and tumors of the gallbladder, duodenum, adrenals, pancreas, liver and right kidney. On the left side, lesions of the stomach, spleen, left adrenal and left kidney must be considered. Pneumoperitoneum, followed by roentgen examinations, may assist in the differential diagnosis. However, frequently exploratory celiotomy must be performed before an accurate diagnosis of the abdominal tumor can be made.

TREATMENT

Excision is the treatment of choice if it is mechanically feasible. According to Roller,[8] simple enucleation of the cyst has been associated with a mortality of 9 per cent. When resection of intestine must also be done, the mortality is given as 25 per cent to 30 per cent. Aspiration of part, or all of the cyst contents may facilitate the excision. If excision is associated with too great a risk, or mechanically is not feasible, marsupialization may be done. Healing usually occurs in a few weeks following marsupialization. Roller[8] states that marsupialization has a mortality rate of 16 per cent. However, it should be recalled that marsupialization is usually done in cases where excision is impossible or impractical.

We wish to present a case of a rather large lymphangioma of the mesentery of the jejunum.

REPORT OF CASE

A white male, aged four years, was presented at the Clinic for examination on March 14, 1947, because of abdominal pain of three days duration and history of increasing size of the abdomen since infancy. The family history was essentially normal. Past history revealed fairly frequent respiratory infections and an otitis media two years previously. Tonsillectomy had been performed in 1945.

The parents of the child stated that there had been some enlargement of the patient's abdomen since birth but that his health had otherwise been essentially normal until the onset of the episode prior to his admission to the Clinic. Approximately three days prior to his registration the child developed abdominal pain in the epigastrium. This discomfort was mild, did not stop his playing and was intermittent in type. The local physician examined the boy, told the parents there was fluid present in the abdomen and referred him

to the Clinic. There were no other symptoms. His appetite was good and his weight was normal for his age and height.

Physical examination revealed a well developed and nourished white male of four years who did not appear to be ill. Weight 35 pounds; temperature 100 degrees rectally; pulse 112; respiration 22; blood pressure 105/70.

There was no palpable lymphadenopathy. Examination of the head and neck was normal. There were no demonstrable abnormalities of the heart and lungs. The abdomen was distended and the umbilicus was everted. There was a suggestion of a palpable mass in the right upper quadrant, the right lower quadrant and the left upper quadrant of the abdomen. One could not be sure if these were lobulations of one tumor or separate

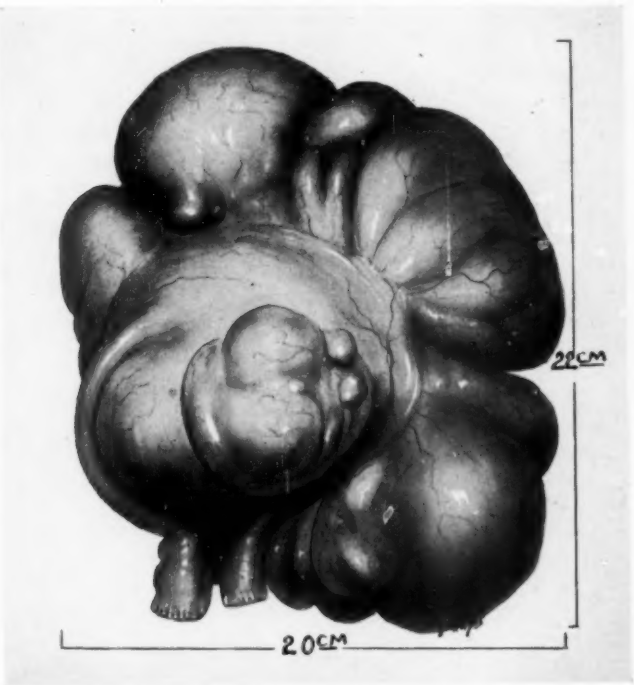

FIG. 1.—Drawing of the tumor, showing the large multicystic lymphangioma of the mesentery of the jejunum.

tumors. There was dullness to percussion over these areas but no fluid wave was elicited. The largest mass was thought to be five or six inches in diameter and none of the areas were tender. Examinations of the rectum and genitalia were normal.

Laboratory reports.—Urinalysis: normal. Hematology: March 14, 1947, hemoglobin 10.5 Gm. per 100 cc. of blood. Erythocytes: 4,520,000. Leucocytes: 9,700. Differential: neutrophiles, 50%. Lymphocytes, 45%. Monocytes, 1%. Eosinophiles, 4%. Hematology: March 18, 1947, hemoglobin 13.5 Gm. per 100 cc. of blood. Erythrocytes: 4,710,000 Leukocytes: 7,250. Differential: neutrophiles, 75%. Lymphocytes, 25%. Sedimentation rate: 20 mm. per hour. Blood morphology: moderate hypochromia; otherwise normal smears. Blood chemistry: blood urea, 23 milligrams per 100 cc. of blood.

Roentgenogram of the chest was negative. A flat plate roentgenogram of the abdomen revealed an indefinitely outlined soft tissue mass in the abdomen with questionable fluid present. The intravenous pyelogram showed normal function of both kidneys. The right

ureter was kinked at the level of the fourth lumbar vertebrae, apparently induced by an extrinsic mass.

The patient's parents were advised that the boy probably had mesenteric or omental cysts and on March 17, 1947, exploratory celiotomy was performed through an upper transverse abdominal incision. There was a large mass approximately ten inches in diameter and five pounds in weight which almost filled the abdomen. No viscera were visible anterior to it.

The tumor was delivered into the wound and it was apparent that it consisted of numerous large cystic masses in the mesentery of the jejunum. The afferent and efferent loops of jejunum entered the neoplasm at opposite ends and the intervening 25 cm. of jejunum were densely incorporated in the tumor. It was impossible to remove the

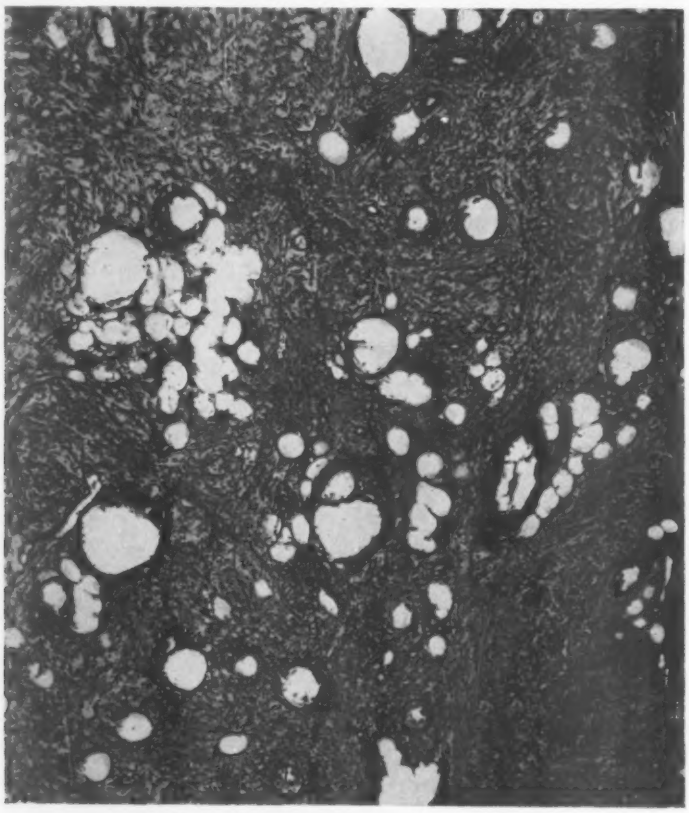

FIG. 2.—Higher power microscopic appearance, demonstrating the numerous, diffuse lymph spaces located in a fibrous stroma containing many lymphocytes.

growth without resecting a segment of the jejunum. Therefore, a segment of the jejunum was resected and the mass removed. The ends of the jejunum were closed and a side to side jejunojejunostomy performed. After removal of the tumor, examination of the remainder of the abdomen did not reveal any other tumors or gross abnormalities except rather diffuse mesenteric lymphadenitis.

The pathologist reported the tumor measured 22 x 20 x 7 cm. and weighed 2033 Gm. The relative large size of the tumor is better appreciated by realizing it constituted approximately one-seventh of the boy's weight. The lesion was multicystic and filled with

a thick milky fluid. Hemorrhage had occurred into some of the cystic spaces, imparting a reddish color to these areas. There was no evidence of infiltration into the bowel by the tumor. Microscopic sections revealed spaces lined with endothelium and a rather large amount of lymphoid tissue in the connective stroma. Laboratory studies of the contents of the lymphangioma revealed a milky alkaline fluid with specific gravity of 1,020. Cholesterol, 88 mg. per 100 cc. Cell count of the fluid showed lymphocytes, 84%; neutrophiles, 14%; eosinophiles, 2%. Erythrocytes: 13,600. Leukocytes: 2,300. Cultures of the fluid did not reveal any growth after 48 hours.

The patient's postoperative convalescence was entirely uncomplicated and he was dismissed from the hospital on the thirteenth day following the operation. Observation three months after surgery revealed his general condition to be good and roentgenograms showed a normally functioning jejunojejunostomy. There was no evidence of recurrence of the lymphangioma.

CONCLUSIONS

1. Tumors of the mesentery should be given consideration in the differential diagnosis of abdominal neoplasms.

2. Benign tumors of the mesentery occur rarely and lymphangiomas are especially unusual.

3. Most lymphangiomas probably begin in embryonic rests of lymphoid tissue.

4. Careful physical examination and roentgenography are the greatest aids in diagnosis.

5. The treatment of choice is excision of the lymphangioma. When this is not feasible, marsupialization may be done.

6. A case of a large lymphangioma of the mesentery of the jejunum is presented. The tumor, including a segment of the jejunum, was removed and a jejunojejunostomy performed, with an uncomplicated recovery.

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ENTEROGENOUS CYSTS OF THE DUODENUM*

Report of a Case That Is Unusual If Not Unique

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ENTEROGENOUS CYSTS are said to be fetal inclusions and may be found anywhere in the intestinal canal. They are related to the diverticula, as described by Meckel and others. The cyst may be likened to a diverticulum

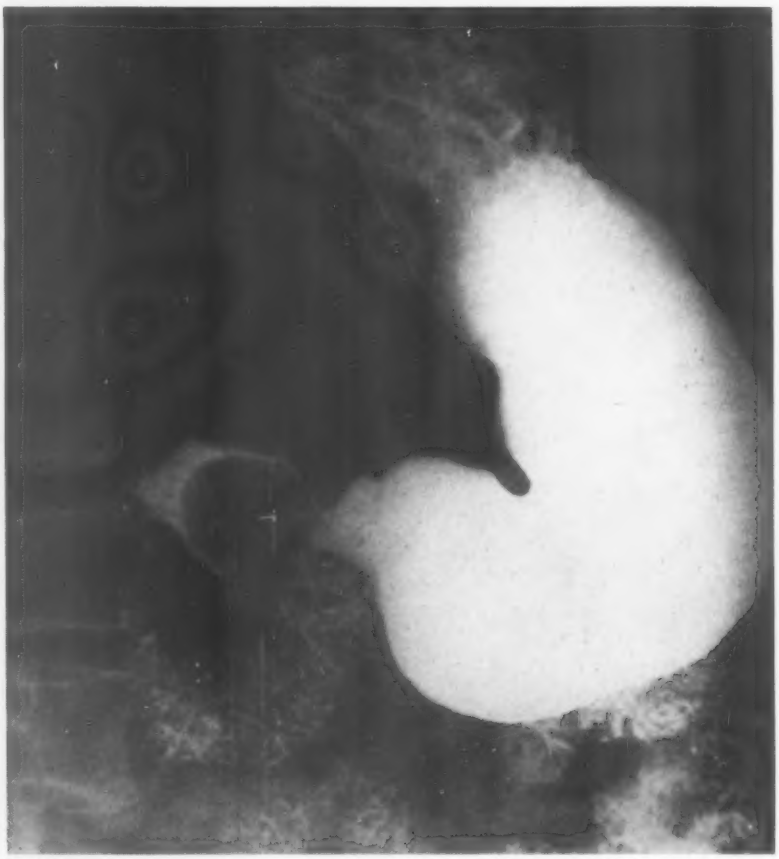

FIG. 1.—X-ray showing the blocking of the pylorus.

which has been cut off, so to speak, with no open end in the lumen of the intestine. Thus it becomes a nidus of secreting cells buried within the wall of the intestine. Structurally it is composed of the coats of the intestine greatly thinned out. It is submerged in the bowel wall and is filled with a clear or

*Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

yellowish fluid. It manifests its presence by obstructive symptoms and is seldom if ever diagnosed before operation.

Enterogenous cysts of the duodenum carry a high operative mortality, said to be 50 per cent. This is due to two factors: first, the very tender age of these patients and the weak and depleted conditions in which they come for treatment; secondly, the location of the lesion close to the entrance of the ducts from the liver and pancreas. The ideal operation, of course, is complete excision. Diversion into the lumen of the bowel and drainage of the cyst have

FIG. 2.—Showing tumor distending the duodenum.

been tried. One operator by-passed the lesion successfully by doing a gastroenterostomy.

A brief summary of the cases of this condition reported to date follows: Gardner and Hart[1] of Durham, North Carolina, reported a successful operation on a girl of 15 years. In a careful review of the literature up to that time, they found only six other cases—all infants. Their case has remained the oldest reported up to the present. Shallow, Wagner, Jr., and Manges[2] of Philadelphia reviewed the literature up to April, 1947, and were able to find

but 13 cases (including the seven mentioned above). To these Dr. Shallow added his case, making a total of 14 altogether. It is significant that of these 14 cases, ten were between birth and four months of age, and the oldest was 15 years. My own case, at the age of 69, must therefore be regarded as unusual if not unique.

CASE REPORT

Mrs. E. R. R., age 69 years, married, with three children. She was strong, very athletic, and gives no history of any digestive trouble in early life.

About 24 years ago she had some digestive disorder and took soda for its relief. She

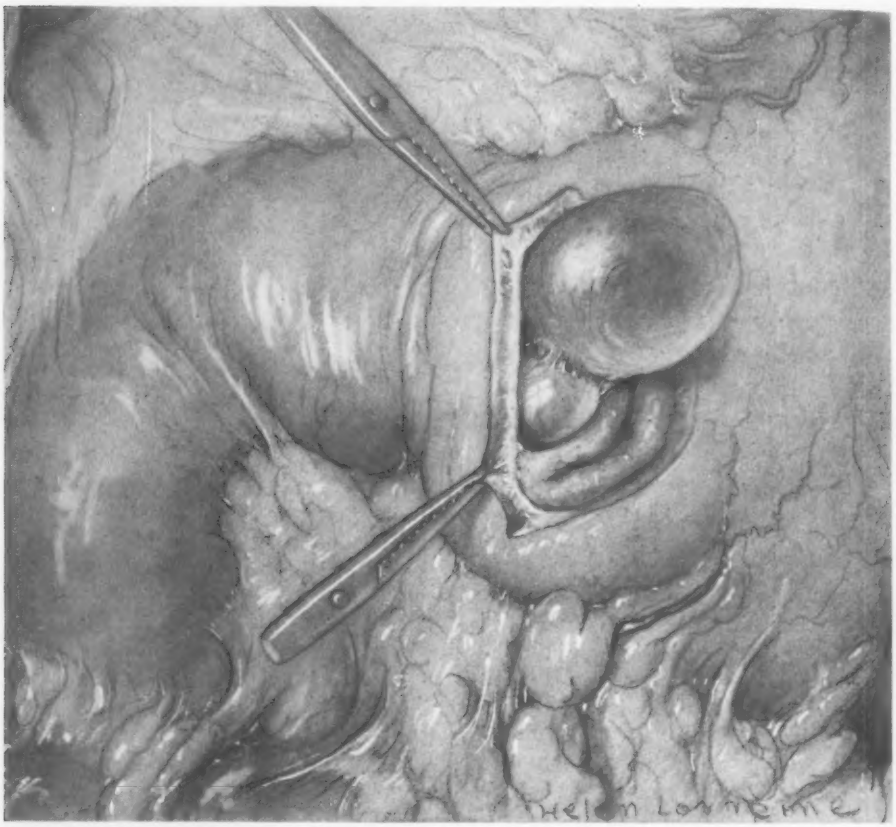

FIG. 3.—Showing incision made in the stomach and exposure of the tumor.

later consulted a physician who obtained a negative cholecystogram and advised a gastro-intestinal roentgenogram. Later her digestive symptoms returned and a gastro-intestinal roentgenographic study was made June 18, 1924. The same roentgenologist who examined the gallbladder reported a large penetrating ulcer of the lesser curvature of the stomach several inches above the pylorus. The duodenum was negative.

She was put on an ulcer diet and recovered. A follow-up of the roentgenogram showed the ulcer healed. She got along with little or no discomfort until the early spring of this year, 1947, when she again had epigastric pain, discomfort and regurgitation of partially digested food. On March 19, 1947, a gastro-intestinal roentgenographic study was made. The report is as follows: "Stomach: There is a good deal of spasm of the pyloric antrum, and the duodenal cap shows a gross central deformity with more or less smooth outline,

the barium being displaced, giving the cap a ring-like appearance. We believe this to be due to a nonmalignant tumor of the duodenal cap."

She was admitted to St. Luke's Hospital, April 10, 1947. The only indications for operation were the history and roentgen-ray report. The physical examination was negative. There was no tumor mass nor tenderness.

On April 11th under general anesthesia an upper right rectus incision was made. The gallbladder was quite normal. The stomach was normal in size and position. In the pylorus and first portion of the duodenum could be felt a tumor, soft and semi-elastic, that could be pushed through the pylorus. A transverse incision was made just proximal to the pyloric ring, into the stomach. Now it was seen not to be a pedunculated tumor or polyp, but a semi-elastic tumor or cyst within the anterior wall of the duodenum and definitely reducing the size of the pyloric lumen. By manipulating the tumor with a finger inside the pylorus we slipped the outer coats of the stomach down and then made an incision down the tumor wall and dissected it from its bed in the wall of the duodenum. We did not open the lumen of the bowel but preserved its mucosa intact.

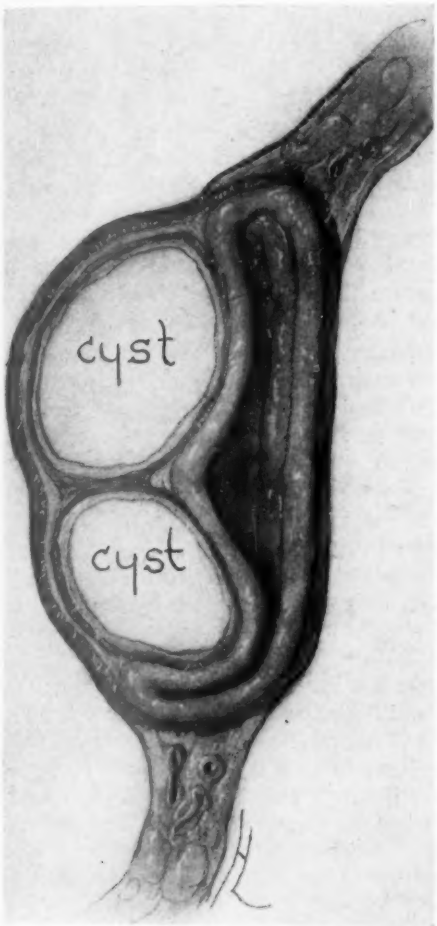

FIG. 4.—Showing the two cysts in tandem and how nearly they have closed the duodenum.

The tumor was about three inches in length by one inch in diameter, and consisted of two thin walled cysts, in tandem, like a dumbbell. They dissected out easily with little bleeding. The wound in the duodenal wall was closed with chromic gut to abolish the dead space. Next the incision in the stomach was closed in the usual way, using blacksilk in the outer layer. The postoperative course was uneventful and her convalescence was without incident.

SUMMARY

Enterogenous cyst of the duodenum is a rare condition. This case is apparently unique because of the patient's age, 69 years. The condition is generally regarded as congenital and yet there is no history in this instance of any gastric trouble in early life. In fact, we have roentgenologic evidence that there was no tumor present 23 years ago when the patient was 44 years old. The symptoms for which she finally sought relief were manifest in the spring of 1947 when the obstructive symptoms began. For a benign tumor to develop in the stomach of a woman 69 years of age, occurring without bleeding and without loss of weight, was of itself unusual. If the origin was congenital why did it

wait 68 years to manifest its presence and what was the factor that activated its growth? These questions I hope may be solved by some listener or reader more versatile than I.

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DISCUSSION.—DR. CHARLES W. MAYO, Rochester, Minn.: I apologize for rising to discuss the subject of lymphangioma of the mesentery inasmuch as I am one of the great majority of surgeons who have never seen or dealt with such a condition. My excuse is that I want to cite the experience at the Mayo Clinic regarding these cysts.

Ewing has classified cysts of the mesentery under four heads: (1) lymphatic or chylous, (2) enteric, (3) urogenital, and (4) dermoid or teratoid cysts.

At the Mayo Clinic, cysts of the mesentery have been observed in 175 cases, in only seven of which the cysts where lymphangiomas. I should like to call attention to one such case reported by Beahrs and Judd* in July of this year, in which the operation consisted of marsupialization and drainage. The patient was a woman 37 years of age, who had a four months' history of difficulty related to the condition. At operation a large tumor was found, which had markedly displaced the other organs in the region. A total amount of about 12 liters of chyle was removed from the multiloculated cyst.

There are a few points of importance regarding lymphangioma of the mesentery. These cysts are multiloculated and one must try to break down the various septa at the time of drainage. One must anticipate infection at the time of drainage and for that reason must administer streptomycin or penicillin after the operation and must place in the cavity some sclerosing agent to help obliterate the sac. Another point is that drainage should be continued for at least a week or ten days after one thinks the drains should be removed.

I was interested in the report of the Doctors Brindley. My idea of a good surgeon is the one who considers before operation what might be found and then deals with it properly at the time of operation, as was done in the case reported by the Doctors Brindley.

DR. DERYL HART, Durham, N. C.: I thought it might be of interest to mention the case of an enterogenous cyst of the duodenum which Doctor Gardner and I saw in 1930 or 1931. This was a child of 15 with a history of recurring attacks of vomiting. There was a tumor which, at times, was quite prominent beneath the costal margin on the right; while at other times it would shrink until barely palpable, or would disappear entirely. When it disappeared she was relieved of her symptoms, when it reappeared vomiting recurred. At operation we found a mass which appeared to be continuous with the stomach, and occupied the region of the first portion of the duodenum and had every appearance of a tensely distended duodenum. The site of the pylorus could not be determined except by the location of the pyloric vessels. The duodenum seemed to be as large as the lower portion of the stomach, was tensely filled, could not be emptied by pressure, and it was presumed that a cystic tumor was present beneath the musculature. The position of the duodenal lumen could not be determined, since the musculature and vessels of the duodenum surrounded the entire mass. The diagnosis had not been made before operation; but the suggestion had been made that it might be a cyst of the common bile duct.

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* Beahrs, Oliver H., and Edward S. Judd, Jr.: Chylangiomas of the Abdomen; Report of Case. Proc. Staff Meet., Mayo Clin., **22**: 297–304, 1947.

In order to determine the relationship of the lumen of the duodenum to this cystic mass an opening was made into the stomach above the pylorus. It was found to be superior and anterior to the tumor. The cyst was so large and so intimately attached to the pancreas that we felt its removal would be too hazardous. As an alternative, we anastomosed the cyst to the duodenum, thus converting it into a diverticulum. We hoped that, since the duodenal musculature surrounded this diverticulum, its contraction would keep the diverticulum empty. The patient reported her condition regularly until she was in her twenties. During this time she had married and had had several children.

Even though this operation has been entirely satisfactory, were I to do it again I would divide a high loop of jejunum, bring the distal end up and anastomose it to the cyst and reconnect the proximal end to the side of the jejunum distal to the anastomosis to the cyst. This, I believe, was the sixth or seventh case reported and the first to be cured or relieved of symptoms.

DR. DONNELL B. COBB, Goldsboro, N. C.: There is little one can add to the informative presentation Doctor Brindley has just made. I would like to present one case which might be of interest since it deals with a child who was operated upon twice for lymphangioma of the mesentery, with an interval of six years between operations.

At the time of the first admission the child was 3½ years old. During the previous year the parents had noticed that the child's abdomen was gradually increasing in size, and the child complained occasionally of an indefinite abdominal discomfort. Four days before admission the child developed nausea, vomiting and constipation, and this was associated with a constant, rather severe pain centered about the umbilicus. On admission the child presented a severe picture of intestinal obstruction and palpation of the abdomen revealed a large mass beneath the umbilicus about the size of a grapefruit.

At operation a very large cyst was found, arising between the leaves of the mesentery of the ileum. The upper part of this cyst was adjacent to the origin of the superior mesenteric artery, in which neighborhood there exists the fetal retroperitoneal lymph sac from which arises the lymphatic vessels which drain the small intestine. In attempting to remove the cyst, which was multilocular, it ruptured, spilling a large amount of milky fluid. The sac, however, was easily removed by stripping it away from the mesenteric vessels with gauze dissection, and the opening in the mesentery was easily closed. We did not experience the difficulty encountered by Doctor Brindley.

The pathologic picture showed the cyst wall to be composed of fibrous and vascular tissue of various density.

The child recovered and six years later was readmitted to the hospital. During the interim she had been perfectly well. Ten days before the second admission she began to have pain in the left upper abdomen and, at that time, the parents first noticed a mass in this region about the size of an orange. At operation this was found to be a similar but much smaller lymphangioma, arising between the leaves of the mesentery of the upper ileum. It was readily removed in a like manner and the pathologic picture was similar to the original lymphangioma.

One of the most important points to bear in mind in dealing with any lymphangioma is the unusual danger of infection. This was first pointed out by Doctor Singleton when he addressed this Association in 1936. At that time he emphasized the point that channels draining lymphangiomata do not always pass through filtering lymph nodes and at times the lymphangiomata have a direct fistula connection with adjacent veins. Thus, if infection does occur, it has ready access to the general circulation. At that time Doctor Singleton quoted Dowd, who had collected 90 cases, most of whom were operated upon with a mortality of 42 per cent, and in nearly all the fatal cases death was due to infection.

DR. G. V. BRINDLEY, Temple, Texas (closing): I appreciate the discussions very much and, in particular, the interesting case reported by Doctor Cobb.

JEJUNAL DIVERTICULOSIS COMPLICATED BY THE DEVELOPMENT OF JEJUNO-COLIC AND JEJUNO-JEJUNAL FISTULAS:— Report of a Case*

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SURGICAL COMPLICATIONS of jejunal diverticulosis are exceedingly rare. Of the 350 odd cases of jejunal diverticulosis recorded in the literature, less than 60 developed complications requiring surgery. A case of diverticulosis of the jejunum with jejuno-colic and jejuno-jejunal fistulas is presented in this paper. We have been unable to find any similar case in the literature.

In 1945, Walker[25] collected 32 cases of acquired diverticulosis of the small intestine with complications. In this review he excluded congenital diverticula of the Meckels' type but included other single diverticula. Among the 122 cases of non-Meckelian diverticula of the jejunum and ileum presented by Benson, Dixon and Waugh[2] of the Mayo Clinic, there were 13 cases with complications. More recently several other case reports have appeared describing complications of jejunal diverticulosis.[13, 15, 19, 27, 28]

Approximately one-half of the recorded complications have resulted from diverticulitis, the inflammatory process leading to peritonitis with or without perforation, abscess formation, or acute intestinal obstruction from edema, kinking, or adhesions. Enteroliths, parasites and other foreign bodies, in many instances causing obstruction, have been found in jejunal diverticula.[24, 26, 18] Hemorrhage has been reported as a major complication in at least four instances.[3, 11, 23, 15] Acute and chronic intestinal obstruction resulting from a volvulus in association with jejunal diverticula, have been recorded three times.[9, 22, 13] Three cases of traumatic rupture are described in the literature.[4, 1, 21]

Benson, Dixon and Waugh[2] have recently added several new complications. They presented cases in which there was evidence of chronic intestinal obstruction with dilatation and hypertrophy of the bowel, apparently on a functional rather than a mechanical basis. They also reported a benign fibroma arising in a diverticulum of the ileum and an adenocarcinoma in a jejunal diverticulum.

CASE REPORT

A colored female, age 41, was admitted to Saint Philip Hospital on December 12, 1946, complaining of intermittent diarrhea, associated with tenesmus and fecal incontinence. She stated that undigested food was frequently passed in the stools shortly after eating. These symptoms had been present for 18 months. Four four years the patient had suffered anorexia and occasional vomiting. No blood or mucus had ever been noted in the stools. During the year prior to admission she had lost a considerable amount of weight. Liver extract had been prescribed for anemia. Menopause had occurred at the age of 35.

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* Read before the Southern Surgical Association at Hollywood Beach, Florida, December 10, 1947.

On admission the pulse was 86, respirations 18, temperature 99 degrees, blood pressure 100/56. Physical examination revealed a poorly nourished, emaciated female. The mucous membranes were pale. Abdominal examination showed slight distention and tympany, but no tenderness. No mass or organ was palpated. Hyperactive peristalsis was heard.

Significant laboratory findings included an anemia of 3,900,000 red cells with 66 percent hemoglobin, a calcium of 8.6 and total serum protein of 4.9. Stools were negative for blood, ova, and parasites.

A barium enema by Dr. Edith Miller of Petersburg, Virginia, performed prior to admission had demonstrated a rather free connection between the transverse colon and the jejunum. With exception of irritability and spasticity of the transverse colon, no

FIG. 1. Showing three jejuno-colic fistulas to the transverse colon.

other abnormalities were noted. A gastro-intestinal series failed to visualize a communication between the small intestine and colon, but the barium entered the colon very rapidly, evidently through the fistulas.

After adequate preoperative preparation, an exploratory laparotomy was performed. A large portion of the small bowel was found bound together by old, thick adhesions, and to this region the transverse colon was adherent. Dissection revealed a large number of diverticula present in the loops of jejunum. These were located on the anti-mesenteric and lateral portions of the bowel as well as along the mesenteric border. Although most were small and covered with a thick bowel wall, some measured ¾ inch in diameter and possessed only a very thin, transparent covering. One of the thinnest was ruptured during dissection and was excised. Three of the large diverticula were exercised and their bases inverted. Further dissection uncovered three jejuno-colic fistulas to the transverse colon (Fig. 1). These originated from a short segment of jejunum and the attachments to the colon were approximately 3 inches apart. Each fistula measured 1 inch in length. The fistulas were removed by clamping and dividing their bases flush with the jejunum and

colon. Eight jejuno-jejunal fistulas were also demonstrated, but these were not disturbed. (Fig. 2.)

Pathologic examination showed the thin wall of the large diverticula to contain only mucosa and a thin layer of muscularis while the fistulas were made up of normal jejunal wall with all its layers.

Postoperatively the patient did well with the exception of one episode of atelectasis in the right lower lung. Diarrhea was checked immediately following operation.

A follow-up five months after operation disclosed that the patient was asymptomatic and had gained thirty pounds in weight. A barium enema made at this time revealed an additional connection between the splenic flexure of the colon and the small bowel. It was not clear whether this fistula had been overlooked at the time of operation or whether it

FIG. 2.—The jejuno-jejunal fitstulas. One small and one large diverticulum indicated by arrows.

had formed during the postoperative period. A gastro-intestinal series failed to demonstrate the connections. The absence of any functional shunt in the direction of jejunum to colon probably accounted for the freedom from symptoms.

Discussion.—Jejuno-colic fistulas arising from peptic ulceration and from neoplastic invasion are not uncommon. In addition, there have been instances in which this complication has resulted from sigmoid diverticulitis.

Since no diverticula were noted along the colon, it is assumed that the formation of fistulous tracts between jejunum and transverse colon and between loops of jejunum developed from jejunal diverticulitis with secondary erosion into neighboring bowel. This is further indicated by the gross and microscopic examinations which showed the fistulous tracts to be of jejunal origin. Diarrhea and malnutrition followed the establishment of jejuno-colic fistulas.

A predisposing factor in this unusual complication may have been the location of many thin diverticula on the anti-mesenteric and lateral sides of

the bowel. In 1906, Gordinier and Sampson[10], comparing jejunal and sigmoid diverticula, stated (with reference to the former): "Their usual situation between the folds of the mesentery renders them less likely to undergo pathologic changes than those hanging free." Here he refers to the location of sigmoid diverticula on the anti-mesenteric and lateral borders and the occurrence of complications in these. However, additional factors rendering jejunal diverticula somewhat immune from inflammatory changes are the liquid nature of the fecal stream in this region and the wide openings of the diverticula into the bowel tending to eliminate stasis.

The usual location of multiple diverticula of the jejunum between the leaves or just to one side of the mesentery has been noted by almost all authors. Single diverticula have not infrequently been found on the anti-mesenteric border, this location perhaps indicating a congenital origin. Edwards[6] stated that multiple jejunal diverticula arose just to one or the other side of the mesenteric attachment, corresponding to the entry of the blood vessels supplying the bowel wall. Klebs[14] first contended that the blood vessels created a weak spot in the intestinal musculature thus permitting herniation of the mucosa as a small diverticulum. This theory of the production of diverticula in association with the entry of blood vessels through the muscle layers, just to one side of the mid-line on the mesenteric border, has gained acceptance by many authors. However, it is now generally agreed that the small jejunal diverticula do not represent true herniations of the mucosa but rather are covered by all layers of the intestinal wall. Many other theories have been proposed to account for the production of jejunal diverticula. Fraser[8] demonstrated an absence or weakness of the longitudinal muscle layer in the mesenteric region. Rankin and Martin[16] concluded that an inherent weakness in the bowel in addition to increased intra-intestinal pressure were the major factors. However, the role of increased intra-intestinal and intra-abdominal pressures is difficult to evaluate and the importance of sclerosis of mesenteric vessels, increased venous congestion, fatty deposits and other proposed factors cannot be substantiated. In order to produce an effective increase in intra-intestinal pressure, Edwards[6] contended that an irregular, segmental contraction of the bowel wall was necessary with relaxation of the intervening segment.

Benson, Dixon, and Waugh[2] stated that jejunal diverticula might occur in any position around the circumference of the bowel, the majority being situated along the mesentery or within its leaves. These authors did not state whether this applied as well to multiple as to single diverticula. In our case, many diverticula arose directly on the lateral and anti-mesenteric sides of the bowel. Association of these diverticula with entry of blood vessels through the muscle layers of the bowel wall would still be possible since branches of the arterial supply penetrate at increasingly oblique angles around the circumference at various intervals from the mesenteric edge.

Formerly, a careful distinction was made between "true" and "false" diverticula, the former term indicating those in which all layers of intestinal wall were present, the latter in which only mucosa and serosa were found. This distinction has also been the basis of division into congenital and acquired diverticula. Edwards[6] in his extensive discussion of the subject stated that the mucous membrane herniated through a weak spot in the muscle wall carrying a few muscle fibers with it. A similar view was expressed by Fraser[8]. However, Butler[4] claimed that in the early stage the diverticulum consisted of all coats, the mucous membrane later herniating through. Rankin and Martin,[16] and Benson, Dixon and Waugh[2] likewise pointed out that diverticula, when small were covered by all layers of the bowel wall. Schmidt and Guttman[20] found all the stages of transition between the two forms, and expressed the view that much confusion would be avoided if diverticula were referred to without reference to the presence or absence of muscle layers. It has even been stated that congenital diverticula may become sufficiently enlarged and stretched as to show the characteristics of the so-called "false" type.

Although the smaller, thick wall diverticula in our case were not removed, grossly they gave the appearance of possessing essentially normal bowel wall in contrast to the large, thin, transparent diverticula which showed no muscularis externa microscopically.

Although many jejunal diverticula were present only a few were demonstrated by gastro-intestinal roentgen-ray study. Difficulty in radiologic diagnosis has been frequently mentioned and attributed to the wide openings of the diverticula. In 1920, Case[5] presented the first five cases diagnosed by roentgenogram. In 1937, Johns[12] found only 26 cases diagnosed by roentgen-ray examniation and of these, only 17 had been confirmed by operation. That multiple diverticulosis of the jejunum has been recognized with increasing frequency on roentgen-ray examination is illustrated by the fact that 16 of the 122 cases presented by Benson, Dixon, and Waugh[2] were diagnosed by barium studies. Ritro and Votta[17] found 25 cases of multiple diverticulosis of the small bowel out of 4,786 roentgen-ray studies of the gastro-intestinal tract over a period of 2½ years, an incidence of one-half per cent.

The symptoms presented by our patient resulted primarily from the presence of jejuno-colic fistulas. However, anorexia and intermittent vomiting may well be attributed to the presence of multiple diverticula. In the absence of frank complications, multiple diverticulosis of the jejunum is a relatively silent disease. A few patients, however, will complain of abdominal discomfort, flatulence, anorexia, and epigastric pain tending to radiate to the left of the umbilicus. Epigastric pain and fullness are said to be relieved by lying down. Ritro and Votta[17] stated that 22 of their 25 patients diagnosed by roentgen-ray gave a history of abdominal complaints, anorexia being present in 50 per cent and nausea and vomiting in almost 50 per cent. Epigastric distress was the most common complaint. The absence of symptoms

associated with jejunal diverticula is probably related to minimal stasis in the sacs and to the presence of only a thin muscle layer covering the diverticulum.

SUMMARY AND CONCLUSIONS

1. A case illustrating a rare complication of jejunal diverticulosis is presented.
2. The occurrence of multiple jejuno-colic and jejuno-jejunal fistulas in this case may be attributed to the presence of multiple diverticula along the lateral and antimesenteric borders as well as the usual mesenteric location.

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DISCUSSION.—DR. LUCIAN H. LANDRY, New Orleans: There is nothing that I can add to Doctor Williams' splendid presentation. I only wish to add a case to this report that came under my observation in October of this year, of a single giant diverticula of the jejunum, without fistulae, however, which presented numerous difficulties so far as diagnosis was concerned. In fact, I think we tried to make almost every diagnosis fit the case from ruptured intervertebral disk to housemaid's knee!

The patient had frequent melanotic stools with griping pains in the umbilical region, so much so that it was thought he might have a liver abscess. Mesenteric thrombosis was also considered, as well as possible reduplication of the jejunum. Later he developed a large tympanitic mass filling the epigastrium, which we took to be a dilated stomach and suggested inserting a Levine tube to allow the gas to escape. The patient stated that it could not be stomach as the mass was still present after vomiting. We then had a gastro-intestinal picture made, which you will see in the slides, showing some barium in

the stomach which is riding above this large balloon-like mass, fully the size of a large grapefruit, partly filled with barium. The second slide shows the large baloon fairly well emptied of barium but still leaving a large gas bubble. Even our very good radiologist refused to "stick his neck out" and make a positive diagnosis from this picture.

At operation we found a large solitary diverticula of the jejunum. A resection and anastomosis was done without any difficulty, but unfortunately the patient died of a heart complication.

Dr. Lon Grove, Atlanta, Ga.: I have enjoyed Doctor Williams' interesting discussion. We have recently seen a 69-year-old woman with a small bowel obstruction due to multiple diverticuli of the ileum. This is the first time we have encountered small bowel obstruction caused by diverticuli. This patient was admitted with symptoms of small bowel obstruction with ileus and was treated with Miller-Abbott tube. Later, x-rays were made, and we were able to demonstrate several large diverticuli of the terminal ileum with no other cause for obstruction. Because of her age, if further evidence of obstruction is manifested, we will probably advise ileo-colostomy. The diagnosis was made only a few days before I left Atlanta and we were unable to have a slide prepared for this meeting.

Dr. James D. Rives, New Orleans: I am in a position somewhat similar to that of Doctor Mayo—I want to discuss a condition that I have not yet seen. A short time ago I operated on a patient with an acute penetrating ulcer, with duodenal obstruction resulting from inflammatory reaction which made resection not feasible at that time. It was demonstrated on gastro-intestinal study that he had multiple diverticula of the jejunum. As might be expected, he developed a gastrojejunal ulcer. I resected the involved section of the jejunum and did a subtotal gastrectomy with an anterior Polya anastomosis. The base of the ulcer was the wall of the transverse colon. The segment of the jejunum used in the anastomosis contained no diverticulum so far as I could tell.

There was relief for about three months and then symptoms recurred. Directly opposite the anastomosis is a large diverticulum lying on the transverse colon. The patient has refused further operation, for which no one can blame him, yet it seems to me he will develop a gastrojejunocolic fistula if something is not done about it, and since he has twenty-five or thirty diverticula distal to the anastomosis, it is difficult to decide what should be done.

Dr. Joseph E. J. King, New York: About four years ago I operated upon a friend of mine for intestinal obstruction. Flat films indicated that the point of obstruction was somewhere near the midportion of the small intestine, with major distension in the lower half of the abdomen. When the hand was passed in various directions in the lower portion of the abdomen the site of the lesion was not determined. However, when it was passed high up toward the stomach, the point of obstruction was detected and, with slight maneuver the entire intestine became free and uncoiled itself like a bull whip. After extension of the incision somewhat higher, it was observed that the obstruction was due to mild fixation of a coil of small intestine to a large diverticulum of the jejunum about five inches below the ligament of Treitz. In fact there were two diverticula situated about two inches apart on the mesenteric side. The larger one was about 1½ inches or 1¾ inches in diameter and the smaller about one inch in diameter, and each had multiple diverticula of the diverticulum. Under the circumstances no attempt was made to remove these diverticula.

The patient made an uneventful recovery and has remained well to date.

Dr. Carrington Williams. Richmond, Va. (closing): I want to thank you for the discussion, and I want to call your attention to Howard Mahorner's recent paper on diverticula of the jejunum and duodenum. Some are difficult to demonstrate and he has some very ingenious means to disclose their presence.

DIPLOIC EPIDERMOID AND EXTRA-DURAL PNEUMATOCELE: CRANIAL DEFECTS AND DEFORMITY*

JOSEPH E. J. KING, M.D.
NEW YORK, N. Y.

THERE ARE MANY VARIETIES of cranial defects, erosions and deformities. The vast majority of these cases result from tumor, infection or trauma, while a lesser number is congenital. The various types of erosions and deformities of the skull associated with meningiomas are usually recognized quite easily. Defects produced by metastatic malignant tumors have a characteristic appearance, show an indefinite "fuzzy" margin and are readily diagnosed on radiographic films. This applies to cranial defects following trauma, osteomyelitis and other diseases.

None of the above mentioned types falls within the scope of this paper. I wish to call your attention to two types of cranial defects, erosions, or deformities caused by—1. diploic epidermoids and—2. extradural pneumatocele of spontaneous origin. Each has a most distinctive and characteristic appearance. Each can and should be diagnosed pre-operatively, and the proper operative procedure can be carried out definitely and precisely, with a great saving of time for the surgeon, and with a corresponding advantage to the patient.

The pathologic and histologic features will not be reviewed, since they have been adequately considered in other papers, e.g. Bailey,[1] King,[2] Schwartz,[3] etc.

DIPLOIC EPIDERMOIDS

Epidermoids arising from the diploi of the skull produce two distinct types of defects on roentgenographic films. The less common type destroys the outer table of the skull and thins out the inner table. The tumor mass is entirely extracranial. The inner table is not perforated, but the mass has a remnant of the outer table of the skull extending for an indefinite distance, eggshell in thickness, over the proximal periphery of the doughy tumor. This lesion is well described by Bucy.[4]

The majority of diploic epidermoids destroy the inner, rather than the outer table of the skull. The lesion evidently arises from a diploic congenital epidermal rest or anlage. It increases in size, and over a prolonged period of time, destroys the inner table of the skull. It grows inward and depresses the dura, and may perforate the dura before the outer table of the skull gives way, except at certain areas overlying the mass. There may be, and usually are, a few areas of destruction of the outer table with smaller openings or lacunae, and thinned out portions of the outer table, between the several openings. There may be "islands" of the outer table of the skull between the openings, of eggshell thickness and consistency, but this condition is less

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

seldom encountered. At any rate, the pressure exerted by the very slowly enlarging mass is *irresistible* and the bone gives way. The inner table is destroyed except for a margin near the periphery 1 cm. to 1.5 cm. wide, which is depressed downward and inward by the slowly advancing tumor. It will measure about 2 to 3 mm. in thickness at its continuation with the normal inner table, and gradually becomes of cellophane thinness at its free margin, and bends and fractures easily.

Overlying the lesion a mass may be palpable, varying in size, and doughy in texture, if a considerable portion of the outer table is destroyed. Otherwise, areas of complete destruction can be detected by the fingers. In no case has impulse on coughing or pulsation been observed. The scalp over the area involved is usually elevated about 1 cm. or more above the remainder of the scalp. The amount of elevation depends largely, but not entirely, on the amount of destruction of the outer table.

Roentgenographic films, stereo-lateral and antero-posterior, reveal a skull defect so characteristic that it should never be confused with any other lesion. This characteristic picture of the lesion is well portrayed by Dr. Cushing's[3] illustration in his paper in Surgery, Gynecology and Obstetrics, May 1922. Although he did not make a preoperative diagnosis, he said that one *should* make a preoperative diagnosis based on the typical roentgen-ray findings produced by the lesion.

The author[2] read a paper on this subject in 1938 before this Association, and reported eight cases of epidermoids. The first one, operated upon in 1923, was almost a duplicate of Dr. Cushing's case except that it was on the opposite side of the skull and there was a slight difference in size. The area of skull involved was the same, i.e. the fronto-temporo-parietal region. The diagnosis of the lesion was made before the operation, based on the detailed description of the cranial defect given by Dr. Cushing, and so far as can be determined, this was the first time a positive preoperative diagnosis of this tumor was made.

I shall repeat from this paper the description of a typical diploic epidermoid involving the cranial vault, with greater destruction of the inner than the outer table of the skull.

> "A typical cranial defect produced by the diploic type, in which the inner table is more involved than the outer, when viewed so that the greatest diameter of the defect is shown, has a scalloped, dense, clear-cut margin, showing that this bony margin is more compact than the remainder of the skull. One or more bony hiatuses may be observed in the skull. These represent areas where the outer table of the skull has been completely destroyed. These openings, if they exist, are more apparent on stereoscopic films. The margin of these lesser defects may also be dense and sharply defined. Small pieces of detached islands of bone may be seen. The outstanding and differentiating feature of the cranial defect, however, is the sharply defined, dense, white, scalloped margin which is found in no other condition. Any other eroding lesion, regardless of its nature, produces

a defect in which the margin is less sharply defined, more hazy, and may be fuzzy and soft.

If the roentgenogram is taken so that one views the defect "on edge" as though looking at a saucer edgewise, a dense line about 2 mm. or more wide will be seen extending from the upper to the lower limits of the defect. This is due to superimposition of the dense margins of the defect which brings the compact bony margins in alignment. The outer table may be so thin that it may not be visible at all in an under- or over-exposed film. The characteristics of the defect are positive and unmistakable."

The lesions reported vary in size from about 1.5 cm. in diameter to 7.5 cm. or more. The distinctive features of a cranial defect caused by this lesion are more apparent on roentgen-ray films of the larger than of the small tumors. The scalloped border is more marked and the density of the margin of the defect is more apparent. It is believed that the density of bone forming the margin is due to the slow, steady, prolonged pressure exerted by the tumor on the bone about its periphery, which produces solidification by compression. The bony structure is compressed by the irresistible force of the slow growth of the tumor and not invaded and destroyed by tumor cells as in the case of meningioma or the malignant lesions. Compression, producing increased bone density at the margins of the defect, is far in advance of the destruction of bone. The major force of the tumor in its expansion affects to the greatest degree, that part of the skull which offers the least resistance; that is, the inner or outer table. The greatest resistance offered to the tumor is at its periphery where the surrounding bone is a strong bulwark or buttress. The inner table is completely destroyed for the most part and the tumor mass may occupy a relatively enormous amount of intracranial space compared with the smaller diameter of the cranial defect. Giving away and destruction of the inner table minimizes but does not stop the pressure on the margin of the periphery.

The hollowed, scalloped margin is lined with an epithelial lining—the only viable portion of the tumor—and the epithelial cells do not invade the bone. Practically all of the lesion seen at operation consists of the exfoliated epithelial cells cast off from the inner, older layer of the epidermal lining. Were it possible for these dead exfoliated cells to be discharged through a small fistulous tract through the scalp as fast as they are exfoliated, there would be no expansion of the growth, no compression and destruction of bone, no apparent cranial defect,—and no opportunity to discuss this subject.

In 1936, Mahoney[6] reported a case of unusual design and pattern, but presenting a definite sharp line about the margin of the defect. In 1936 Love and Kernohan[7] made the preoperative diagnosis in "Case 9." The diagnosis was based on the presence of a doughy mass in the temporo-parietal region and the rotentgenographic findings. Munro and Wegner in 1937[8] reported a case of epidermoid of diploic origin. They stated: "X-rays showed bony defect pictured in Fig. 1." A preoperative diagnosis was not made (at least not stated) but the illustration presents the typical cranial defect produced by

a diploic extradural dermoid. In 1939 Alpers stated:[9] "Skull cholesteatomas (epidermoids) may be diagnosed before operation since they have a characteristic roentgenographic picture." In 1940 Love and Bailey[10] made the preoperative diagnosis in a case in which the tumor involved the left half of the occipital bone. This large tumor weighing 200 Gm. displaced the occipital

A B

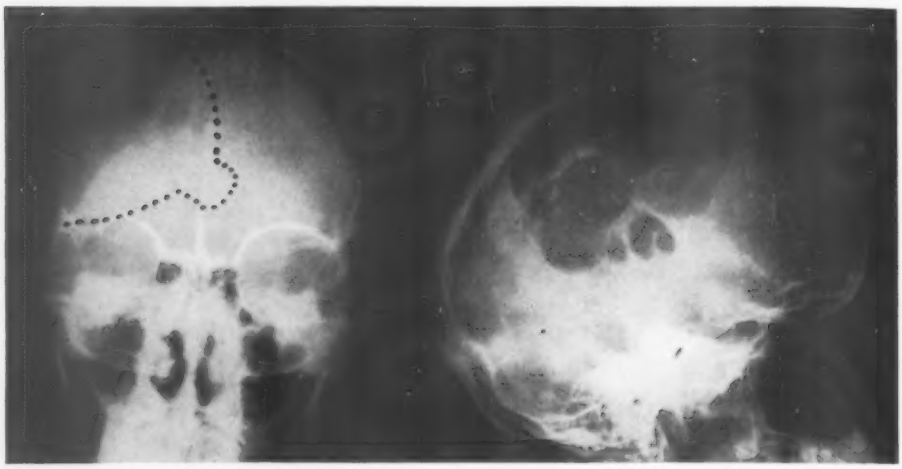


FIG. 1 (a and b). Case 1, W. M. Roentgenograms of skull. (a) Postero-anterior view showing defect and approximate size and shape of tumor. (b) Lateral view showing definite white, dense, scalloped margins and bone destruction.

lobe to a marked degree upward and forward and the cerebellar lobe downward and forward. The tumor was removed completely.

In 1943, in a report of a large series of cases, Rand and Reeves[11] stated the following:

> "That the diploic or cranial epidermoids may often be confusing unless one has their identifying characteristics in mind is evident from the eleven cases just presented. So typical is the roentgenographic appearance of the growth that usually the preoperative diagnosis can be established from the films. In spite of this fact, these tumors are undiagnosed. Four of the tumors in our series of cases were operated upon as sebaceous cysts. In Case 4, four operations were necessary before complete removal was effected. The diagnosis was established only after roentgenograms were reviewed. After an incomplete removal in Case 5, the patient had repeated aspirations for a period of four years. She was then seen by someone familiar with the diagnosis. A review of the roentgenograms taken four years previously revealed the characteristic picture of a cranial epidermoid. . . . Because the diploic or cranial epidermoids are so easily diagnosed and can be treated so successfully surgically, it is important that they be recognized before they reach a size which might make complete removal impossible. The importance of this fact is seen in Case 9."

In 1944 Thornhill and Anderson[12] reported a case of diploic epidermoid of the frontal region which produced unilateral exophthalmos. Although a positive diagnosis was not made before operation, an epidermoid was sus-

pected. The nature of the lesion was recognized at operation, the entire mass was removed, and the postoperative course was uneventful.

The rate of increase in size of the tumor is not known. It may be almost as old as the patient. Decidedly it is a lesion of slow growth. One may obtain some idea as to its slow development and increase in size by review of Case 9 reported by Rand and Reeves in March 1943. The presence of the tumor was determined definitely when the patient was nine years old at which time it was thought to be a wen or sebaceous cyst of the scalp. For the tumor to be detected, it probably had pre-existed for a period of months or perhaps years. Operations were performed at the ages of 34, 36, 64 and two operations were done subsequent to the age of 64.

Since the original report the author has operated upon four cases, two of which had refilled with epidermal debris, in cases where all the epidermal lining could not possibly be removed,—one after 11 years,—and two new cases. One of these shows several rather unusual features. It is the largest diploic epidermoid operated upon by the author and the largest reported in the literature, so far as can be determined. Horrax, Yorshis and Lavine[13] reported an enormous *intradural* epidermoid, encapsulated with a calcified capsule. This, however, is not the type of lesion under consideration.

CASE REPORTS

Case 1.—Bellevue Hospital; History No. 5-166 and 34161-42. *Epidermoid, diploic, extradural, fronto-parieto-occipital region, large. Dural invasion and perforation. Preoperative diagnosis made. Operation with complete removal. Resection of dura with fascia lata graft. Recovery.*

W. M. White, male, age 54, married, laborer. Admitted June 22, 1942 as a first admission complaining of weakness of the left leg for two years.

Past history.—Fracture of both bones of the right leg in 1917. Kidney stone removed ten years ago. Asymptomatic since. Pneumonia in 1921. Appetite good and drank moderately until a few years ago. Appendectomy several years ago.

Present illness (history obtained by Resident).—Onset began ten years ago (1932) when he fell from a ladder and struck the right side of his head. Unconscious for unknown length of time; remembers hearing people talk, but could not answer. Sent to Columbus Hospital, stayed a few hours and went home. About two weeks later roentgenographic films were made and reported negative. Remained away from work 5 to 6 weeks. The first time he tried to climb a ladder he was dizzy; stepped down, and then climbed the ladder again. No trouble since until two years ago (1940) when he felt awkward and had difficulty with his left leg going up and down stairs. This has continued to the present time. A few weeks ago he struck his left shin and it became infected. He was admitted to the hospital. Following discharge he was referred to the Neurologic Clinic of Bellevue Hospital.

He noted on occasions tingling and numbness in tips of left fingers over a period of months. In the spring of 1941 he was standing on the dock watching a ship pull out. He had a sensation of being drawn in the direction of the vessel and fell into the water. He was taken to Harlem Hospital. Apparently nothing was noted, and he was discharged. Since then he has had a throbbing sensation in the right frontal area. No diplopia; no spots before the eyes.

Neurologic examination.—The patient was alert, cooperative and well oriented as to time and place. "Osteoma" (?) of right parietal area. Pupils reacted to light and

convergence. Left pupil larger than right. Fundi:—right disk clear; left blurred, with 1 plus elevation. Arterio-sclerotic changes of vessels of both sides. E O M intact. Left peripheral facial weakness, apparently old. Other cranial nerves intact. Deep tendon reflexes of upper extremities equal, biceps somewhat increased. Knee jerk slightly increased on left. Abdominals absent on left; present and active on right. Cremasteric present and equal. Babinski equivocal on left, absent on right. Some weakness in flexion of left thigh on trunk. Slight weakness of left arm; none of extensors and flexors of feet.

Sensory intact to pinprick, cotton, temperature and vibration. Position sense unimpaired. When walking, slight eversion with tendency to drag left foot.

Past pointing test.—Left arm shows slight gross tremor. Heel to knee test in left leg negative.

Laboratory data.—Urine clear, 1024, negative. Blood. WBC 6,200. polys, 41, lymphs. 59; RBC 3, 900,000 hemaglobin 14.2 gm. Wasserman negative. N.P.N. 29. Sugar 98.

Lumbar puncture.—Initial pressure 290, crystal clear. Wasserman negative. Cells 0. Total protein 34.3.

Roentgenologic examination of skull. (Fig. 1a and b) (J.E.J.K.) *Lateral view.*

"There is a large cranial defect of the right fronto-parieto-temporo-occipital region which presents all the typical characteristics of an epidermoid, but the largest ever seen by the observer. It measures on the film 10.5 cm. in the horizontal, and 9 cm. in the vertical directions. Upwards it extends so far that only the thickness of the skull appears above the limits of the defect; forwards 7.5 cm. from the upper limit of the frontal sinus; downwards to within 1.5 cm. of the upper border of the petrous portion of the temporal bone; backwards to within 6.5 cm. of the external occipital protuberance. The margins are definite and clear-cut, throughout, dense, white, about 1 mm. thick, scalloped and typical of an epidermoid. Several hiatuses or lacunae are present, some quite large, and in some areas the bony structure of the skull is very thin or probably absent. (Schwartz reported a similar case.) The remnants of bone overlying the defect present a bizarre picture,—like seas, bays, islands, lakes and peninsulas.

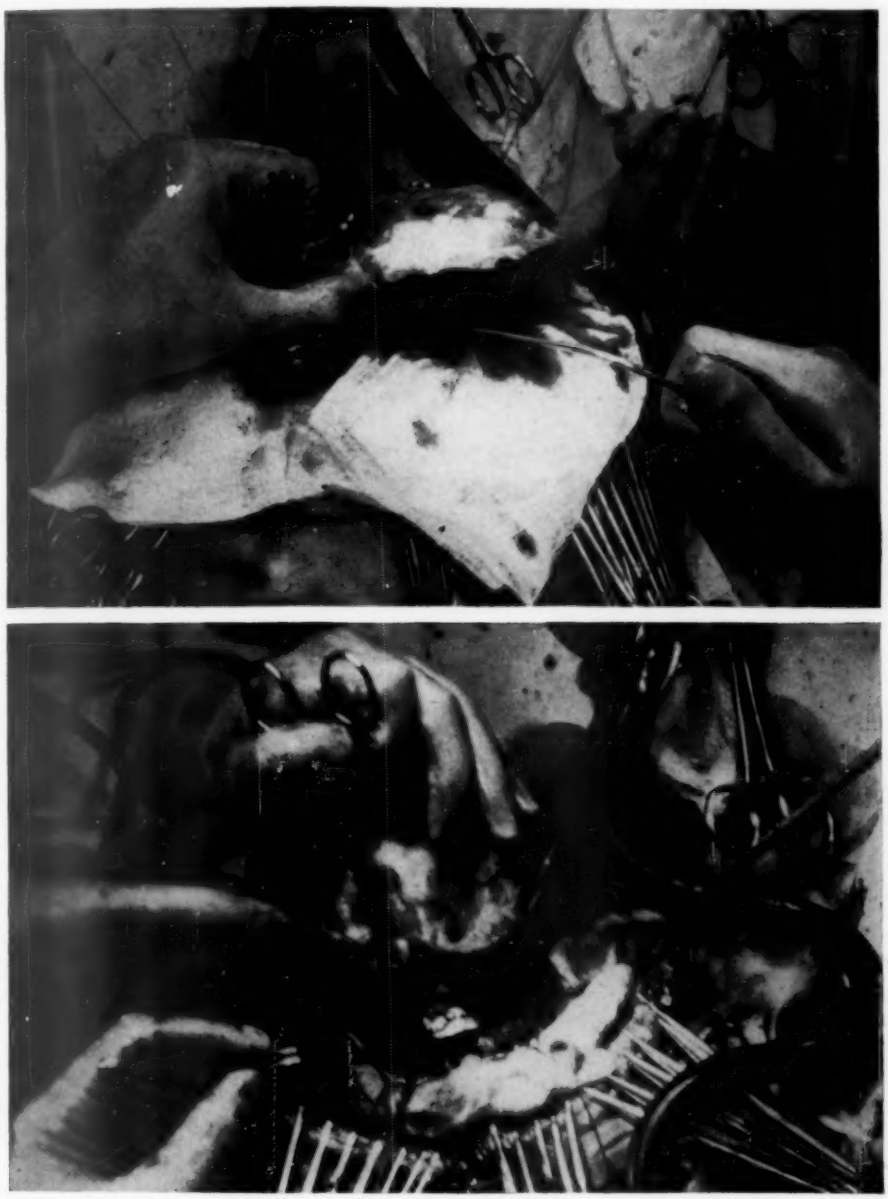
On the *antero-posterior* view, the defect is clearly revealed. The skull is eroded, the greatest amount of erosion being near the center of the defect where the outline of the outer table of the skull is barely perceptible for a distance of 3 cm. The overlying bone presents a cloud-like appearance. There is a distinct white line, about 1.5 mm. thick which runs from a point near the vertex,—1.8 cm. from the mid line, downward, slightly depressed and outward for a distance of 9.5 cm. This white line results from the superimposition of the anterior and posterior dense margins of the defect. This line is 4.5 cm. from its central portion to the outer table of the skull. The tumor itself, which cannot be seen, will be found to be enormous, and will extend much farther inward than the distance of the white line from the outer table of the skull.

Diagnosis: Epidermoid, diploic, extradural. Complete removal of the tumor, including its bony margin, advised.

Operation.—July 2, 1942. Local anesthesia, novocain solution 1% and ½% with suprarenin. After the head was completely shaved the outline of the bulging mass could easily be determined. It measured approximately 10.4 cm. in diameter and was elevated in the central portion about 1.5 to 2 cm. above the surrounding area. A horseshoe-shaped scalp flap, hinged below in the temporal region, was elevated and turned down. It consisted of scalp, galea, and temporal muscle and fascia, leaving the pericranium attached to the skull. Eight burr holes were made in the normal skull just beyond the margin of the tumor and the burr holes were connected with a deVilbiss forceps and Gigli saw, and the block of bone was loosened. Normal dura was seen through the groove made by the forceps. The block of bone was tilted upward and the typical pearly-white tumor mass came into view. It was very large and bulky and depressed the dura and

brain about 8 cm. at its central portion from the inner table of the involved skull. The tumor was not adherent to the dura except at its apex. It was gradually, easily elevated from its depressed dural envelope up to a certain point (Fig. 2a). None of the tumor fractured off the main body. At its most advanced and deepest portion, the tumor had perforated the dura and a knob-like mass of the tumor about 2.5 cm. in diameter and

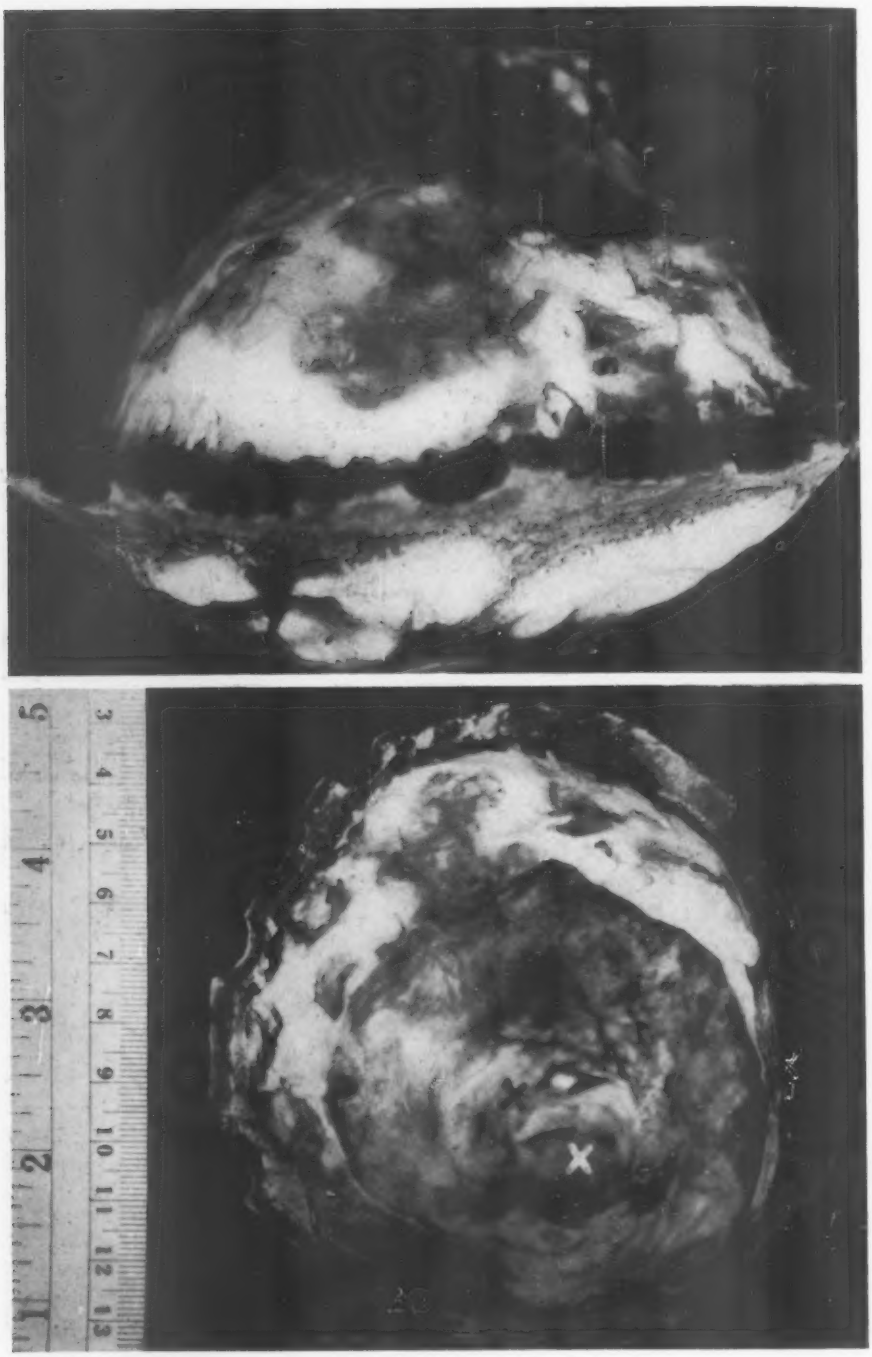
A



B

FIG. 2.—Case 1, W. M. (A) Elevation of tumor from dura. (B) Shows protruding knob-like mass perforating dura. Dural edges seized with clamps.

A



B

FIG. 3.—Case 1, W. M. (A) Lateral view of specimen, showing white pearly mass in bone segment, elevation of bone over normal skull and dural cuff rolled up around knob-like mass. (B) Surface view of specimen showing tumor packed in bony saucer with safe margin, resected portion of dura and knob-like projection at x.

2.5 cm. long protruded through the dural opening against the brain (Fig. 2b). There was a distinct neck on the mass where it perforated the dura, about 1.5 cm. in diameter, to which the dura was firmly adherent. One was reminded of an old-fashioned football turtle-neck sweater drawn over the head.

In order to effect complete removal *en bloc*, a circular portion of the attached dura measuring about 5 cm. in diameter was removed and left attached to the tumor. The knob-like protrusion had made a nest-like depression in the cortex and was very faintly adhered to it. These light adhesions were easily separated, the entire tumor was delivered and removed intact. (A description of the tumor and its bony cup will be given later.)

There were no adhesions between dura and cortex. The dura was considerably thinner in its central portion, which was excised. The dural defect was closed with a

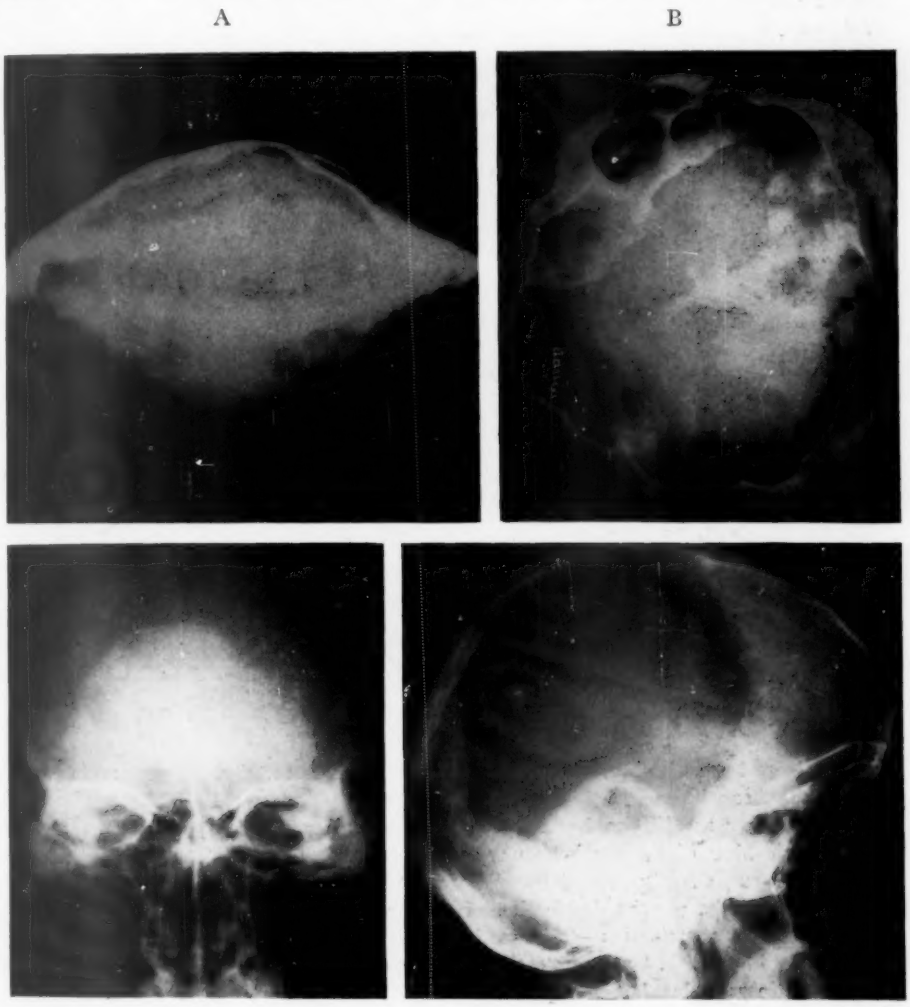
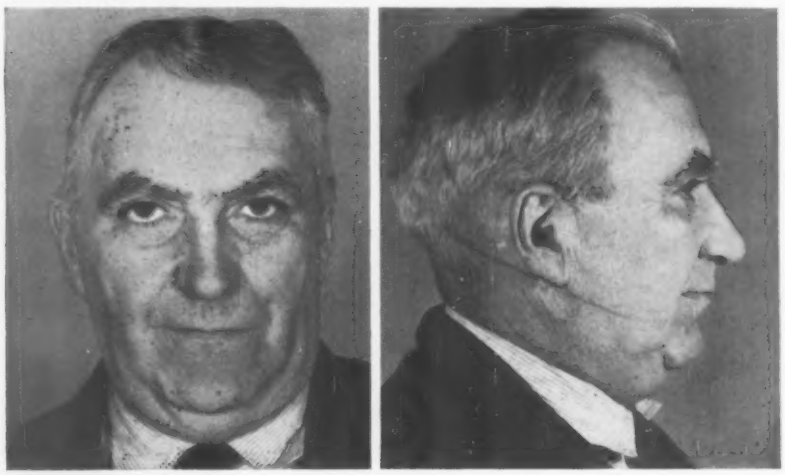


FIG. 4 (A and B). Case 1, W. M. Roentgenograms of specimen. Diploic epidermoid. These clearly show the white line of condensed bone surrounding the defect, partial destruction and manner of erosion of skull. C and D, Postoperative roentgenograms, November 26, 1947.

transplant of fascia lata, the scalp flap was returned to position and the incision closed in two layers with interrupted silk sutures. The skull defect was not repaired because tantalum was not available and tibio-periosteal transplants were not considered advisable at the time on account of the size of the dural defect. The usual head dressing, covered with a plaster shell was applied. The patient left the table in good condition. Blood transfusion was not indicated.

Description of specimen.—The specimen was unique in appearance. It reminded one of a shell or saucer over-filled with vanilla ice cream (Fig. 3a). It consisted of a block of skull approximately circular in shape, 10 cm. in diameter. The tumor mass remained intact, packed tightly within the confines of the bony shell. It was not removed from the bone. For this reason one cannot describe the color of the outer surface of the epidermal covering of the tumor lining the excavation. The exposed surface which was overlying the dura and in contact with it was pearly white, velvety and smooth. The knob-like projection, with its dural cuff turned up about it like a coat collar, is seen. The tumor was approximately 7½ cm. thick. The amount of elevation of the overlying outer table above the normal level of the skull could be seen. Fig. 3b is a photograph of the inner surface of the lesion showing a safe margin of bone beyond the lesion, the pearly white surface and the knob-like intradural portion of the tumor with the excised circular dural segment. The outer table was elevated over the site of the tumor and resulted



A B

Fig. 5 (A and B). Case 1, W. M. Photographs of patient, November 26th, 1947.

from prolonged sustained pressure from within. It is covered with pericranium. No definite holes can be seen, but there are a few small doughy areas. The total weight of the specimen was 310 Gm. but the weight of the epidermal mass was not determined. Radiographic films of the specimen were made (Fig. 4a and b). These accentuate the smooth clear-cut, sharply defined bony margin of the defect, and the smaller openings or lacunae, and the uneven destruction of the outer table.

Microscopic examination.—"Shows in one section a well-defined thin cyst wall which is lined by a thin layer of stratified squamous epithelium. (No mention was made of kerathyalin granules, but these were present.) A small cyst is seen in section, filled with amorphous pink polyhedral bodies. Another section through the dura shows a similar layer of epithelium closely attached. In one area there is round-celled infiltration.

Diagnosis.—Epidermoid (cholesteatoma.)"

The postoperative course was uneventful. All weakness of the left leg disappeared

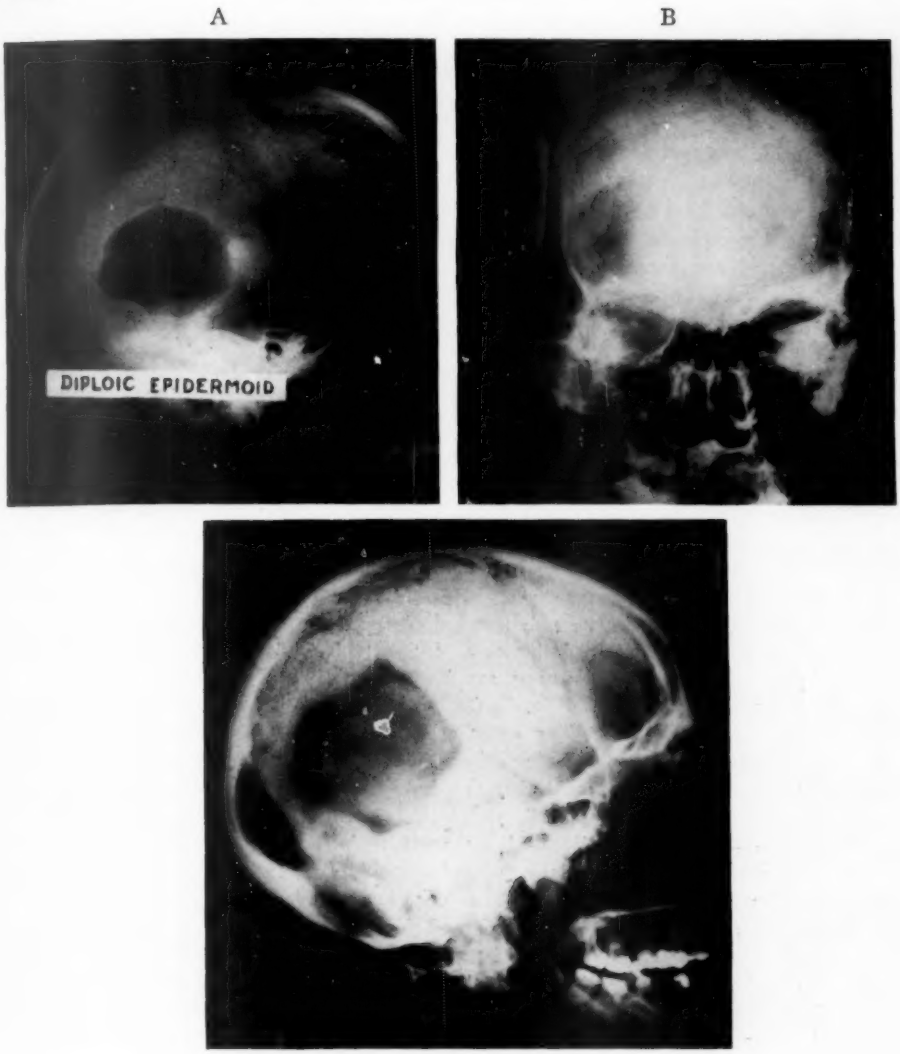


Fig. 6 (A, B, and C). Case 2, K. MacK. A. Lateral, and B, postero-anterior roentgenograms of cranial defect. C. Postoperative lateral view.

and, on getting out of bed on the twelfth postoperative day, he stated that he felt as strong as years ago. Follow-up radiographic films made on July 23, 1942 showed the operative defect. He was discharged on July 24, 1942 the 22nd postoperative day to Social Service, which provided him with a perforated celluloid protector to wear in his hat over the defect. He was informed that a tantalum plate could be inserted after the War but he said he was satisfied. He was later seen in the clinic and it was reported that he had returned to work.

On a recent visit to the office, he stated that he was in splendid health and had no complaints. The strength had completely returned on the left side. He is working as a porter in a nearby apartment house and has never missed work on account of illness. He wore no protector and did not want a cranioplasty. He gained 40 pounds since discharge from the hospital. His neurologic examination was negative. There was

some flattening of the right side of his head, rather well concealed by his hair. The skull defect (Fig. 4b) had filled in considerably about the periphery, but there was no reformation of bone in the central portion of the defect (Fig. 5a and b).

Case 2.—(Lawrence Hospital; History No. 40711).—*Epidermoid, diploic, extradural, temporo-parietal. Preoperative diagnosis. Complete block removal. Resection of dura with fascia lata graft. Recovery.*

K.MacK., white female, age 46, married, housewife, admitted Jan. 17, 1940; referred by Dr. O. L. Austin. Radiographic films of the skull had been made about two weeks previously and were shown to the author. A cranial defect was present in the right parietal region. It presented all the characteristics previously described in this paper—and the diagnosis of diploic extradural, epidermoid was readily made. Complete block removal of the tumor was advised.

History was essentially negative except for some pain in right shoulder last September. Roentgenographic films were made of neck, head and sinuses as a routine, and the lesion of the skull was discovered. She had been well otherwise, with no complaints. The examination was entirely negative except for slight increase in deep reflexes on the left side and a slightly elevated mass in the right temporo-parietal region.

Roentgenologic examination. (J.E.J.K.)—"On the lateral view (Fig. 6A) there is present a cranial defect of the right temporo-parietal region which measures 6 cm. in the horizontal and 5 cm. in the vertical diameter. The margins of the defect are mildly scalloped, very dense, firm, and sharply defined. (Schwartz's Fig. 1 presents an almost identical picture.) There is gross destruction of the bone with some very thin areas in the outer table, and complete destruction of this table, especially in the anterior half of the defect where the doughy mass can be palpated.

The antero-posterior view (Fig. 6B) shows a dense white vertical line about 2 mm. in thickness and 5 cm. long. The outer table is very indistinct due to thinning and destruction and can barely be distinguished. The characteristics are so definitely those associated with diploic epidermoid that the diagnosis is unmistakable.

Diagnosis: Diploic epidermoid."

Operation.—Since the patient did not want to be conscious during the operation, avertin and open ether anesthesia was used instead of local anesthesia. A horseshoe-shaped incision was made hinged on the temporal muscle below. The scalp flap including the pericranium was elevated and reflected. The pericranium was intimately adherent to the tumor where the outer table had been destroyed. Over these areas the pericranium was left attached to the skull so that the tumor would be left intact and could be removed en bloc. A burr hole was made above and below the margin of the defect in normal bone and burr holes connected with deVilbiss forceps. The bone segment was loosened. The dura was stripped from the shelf-like depressed margin of the inner table. The lining membrane of the tumor, as thin as cellophane, was carefully stripped away from the attenuated depressed dura towards the central portion of the depression. In this area the lining membrane was more firmly attached. To prevent leaving some of the membrane (which is the only viable portion of the tumor) and risking the possibility of recurrence, the central portion of the thin redundant dura was removed, still attached to the tumor mass. A dural defect about 3 cm. in diameter remained. The dura was not adherent to the cortex. A fascia lata transplant was used to repair the dural defect and the repaired dura was floated up with warm saline solution to prevent adhesions between the site of the transplant and cortex. The scalp flap was sutured in two layers with interrupted silk sutures and a compressing head dressing was applied. The patient was returned to her room in good condition.

Inspection of the specimen.—Segment of bone surrounding tumor measured about 6.5 cm. in diameter with rim of skull ½ to 1 cm. wide. This was the only tumor of this type seen by the author, which destroyed both tables of the skull to such a marked degree. The two hiatuses in the outer table measured 2 cm. by 4.5 cm. and 1.5 cm., respec-

tively. There was total destruction of the inner table beneath th mass, the defect measuring 5 cm. in the horizontal, and 4 cm. in the vertical directions. The epidermoid mass was packed and stuffed into the cavity of the bony cup like a deviled crab. The remnants of the inner table margin were depressed inward and fitted close to the tumor. The extreme free edge was as thin as paper and had a feathered edge, like new-forming ice on a pond. The tumor surface was pearly white, lamellated, smooth and glossy—typical of an epidermoid.

Photographs and radiographs were made. The mass was placed in decalcifying solution and the tumor with its surrounding bone was sectioned in halves on March 13, 1940. When laid open the two halves resembled somewhat an opened oyster. Sections of the lining and bone to be made by the pathologists.

Pathologic report: "Epidermoid, skull."

Recovery was uneventful.—Patient out of bed on eleventh day and discharged on the fourteenth postoperative day. She has remained well with no complaints referrable to her head. Lateral roentgenogram was made about nine months after operation (Fig. 6c). In 1944, a supra-vaginal hysterectomy was performed under spinal anesthesia for multiple fibromyomata. Uneventful recovery.

COMMENT

The largest diploic epidermoid ever seen by the author or reported was found in Case 1. Roentgengraphic films in both cases revealed characteristic features of a cranial defect resulting from destruction by an epidermoid tumor. Diagnosis was readily made in each case. Block removal with resection of the dura and repair with fascia lata transplant was carried out to assure complete removal of the lesion. The tumor perforated the dura in Case 1. Reinsertion of the block of bone, after currettage and boiling, was not done at the time, on account of the fascial transplant. This procedure could readily have been done at a later date, but it was not desired by the patient in Case 1, and it was not necessary in Case 2.

Preoperative diagnosis of this type of lesion can and should be made and complete removal should be carried out, except where the underlying dura contains an important structure, e.g. the lateral sinus. In this situation currettage and application of Zenker's fluid must suffice.

EXTRADURAL PNEUMATOCELE

Pneumatocele, aerocele or pneumacephalus which follows compound fractures, gunshot wounds, etc. will not be discussed in this paper, and such conditions which have frequently been reported, are excluded.

This report is concerned with two cases of spontaneous accumulation of air in the extradural space between the dura and the skull *without* perforation of the skull. The resulting skull defect is so typical and characteristic that a preoperative diagnosis can and should be made. Had I known what is to be reported here *before* operation was performed on my first case, the patient would have been spared much hospitalization and time lost from his work. Had I not mislaid and failed to read the paper of Woodall and Baker,[14] published in 1941, no doubt the same declaration could be made.

The condition is rare and the radiographic films may be baffling and bizarre to the uninitiated, as they were to several of us in the first case.

No one who observed these films had ever seen the like before. It was the consensus of opinion, including that of F. M. Lau (who made the films) that we were dealing with an hemangioma of the skull. No other diagnosis was made until after operation.

The roentgen-ray films are similar in their characteristics, the principal difference being in size and position. The proper preoperative diagnosis was not made in the first case, but was made in the second. There is no other lesion of the skull which resembles that produced by an extradural pneumatocele. A detailed description of the lesion will be attempted.

CASE REPORTS

Case 3.—(Bellevue Hospital; History No. W-65 and 10174-43).

Pneumatocele, extradural; parieto-temporo-occipital, right. Preoperative diagnosis not made.

Operation.—*Re-accumulation of air with infection. Sequestration of part of bone block. Second operation. Recovery.*

J. B. White, male, aged 33. Married. Bus driver. Admitted as first admission on March 1, 1943.

History.—Patient stated he was entirely well except for a running ear on the right side in childhood, until 1931 when he sustained a head injury. No roentgenograms were made. Said to have been bed-ridden for several weeks, but had no immediate sequellae. About 1934 he began to have occasional headaches which came on suddenly in the right frontal region. These headaches were sharp, stabbing, intermittent for a few days and then did not recur for months. In 1939 he had bouts of headaches for which he sought medical aid without obtaining relief. After several months they ceased, and became intermittent at irregular intervals.

On January 5, 1943 while pulling down the shade behind his seat in the Fifth Avenue bus, which he was driving, he lost his balance and struck the right side of his head against the seat, and he "saw stars." He was stunned momentarily, but was able to drive his bus for another hour when his day's work was finished. That night he had bloody discharge from his right ear, but no other sign or symptom. He worked all through the next day, during which he had intermittent bleeding from the right ear. That evening he was referred by the bus company's physician to Dr. J. Lore, who treated his ear and suggested that radiographic films of the skull and sinuses be made. Roentgenograms made by Dr. F. M. Law revealed a most unusual bizarre picture. The author was requested to see the films and the patient. On January 19, 1943 the patient was advised to be admitted to the Neurologic and Neuro-Surgical Service of Bellevue Hospital.

Physical examination.—Patient is a well developed, well nourished and apparently healthy white male of age 33. His general appearance presents no abnormalities. Examination of the canal of the right ear and ear drum reveals a previously ruptured drum with dilatation of the capillary vessels and small veins around the drum. The left drum and canal are normal.

Neurologic.—Patient well oriented as to time, place and person. Sense of smell grossly intact. Absence of physiologic cupping with blurring of the disk margins. Nerve heads appear normal. There is tortuosity and a mild amount of venous congestion. The disk margins of the left eye are hazier than those in the right. No papilledema can be definitely determined. E.O.M. normal. Visual acuity normal. A C > B C on the right. A C = B C on the left. Weber lateralized to right. Other cranial nerves intact. Gait normal. Romberg negative; no signs of weakness or loss of muscle power. Ankle and knee jerks equal but somewhat exaggerated. Diminished abdominal reflexes. Neurologic examination otherwise negative.

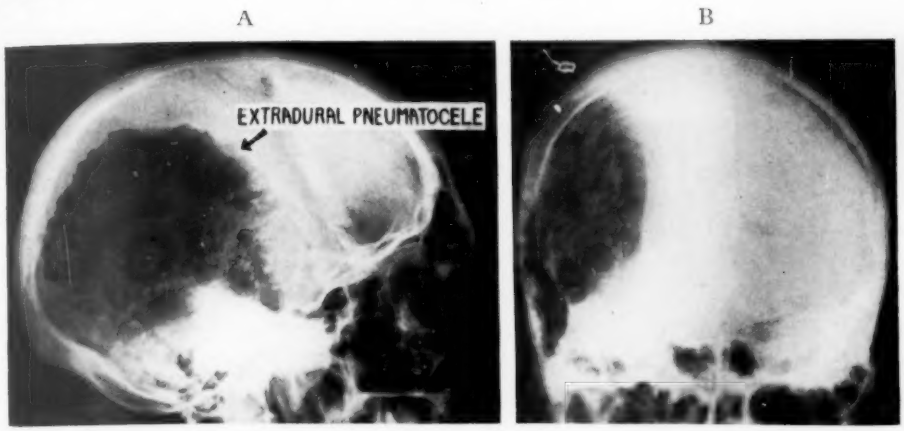


FIG. 7.—(a and b) Case 3, J. B. Roentgenograms of skull showing cranial defect produced by extradural pneumatocele.

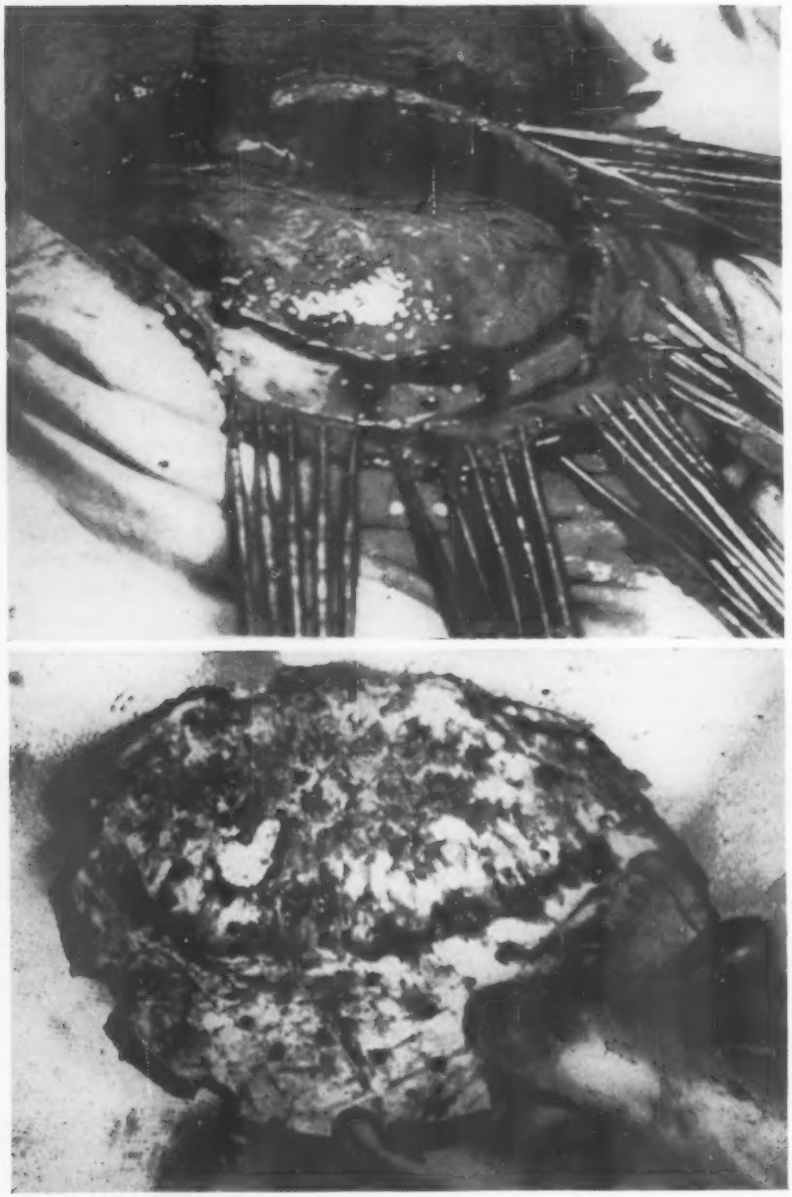
Laboratory findings.—Urinalysis negative. RBC 4,400,000. Hgb. 13 Gm; WBC 7800; polys. 68; lymphs. 3; N.P.N. 31; sugar 78. Blood type zero. Wasserman negative. Phosphatose 5.8; phosphorus 4.34; cholesterol 175; calcium 8.8; Spinal tap: protein 35; sugar 60; Na Cl - 750; Wasserman negative.

Radiographic examination. (Report by Dr. Friedman.)—"There is a large neoplasm 12 cm. in diameter originating in the right parietal temporal and occipital lobes showing enormous cyst-like arrangements with calcium deposits. Findings indicate calcifying *glioma.*"

Roentgenographic findings. (J.E.J.K.)—"*Lateral view* (Fig. 7a). The cranial defect is ovoid in shape and measures 14.5 in the horizontal and 12 cm. in the vertical diameter. The involved area is much darker than the surrounding bone of the skull for the most part, i.e. there is a decreased density of the involved bone. The margins are clear-cut and well-defined. The print of the film gives the distinct impression of looking at the surface of a clean coral rock. The area is trabeculated throughout, denser portions appearing lighter and thinner areas darker. Some areas are almost black. The margins are somewhat scalloped, and the scallops are smaller than those seen in films of epidermoids. They are also more numerous. The margins of the scallops are more distinct at some points and less distinct at others. No point about the margin presents the fuzziness seen in cases of malignancy. One should suspect, but it is not known to us at the time, that air is beneath the skull. The shadow cast by the base of the petrous pyramid is very dense with a small external opening of the auditory canal. The posterior portion of the mastoid shows no cells or else they are lost in the involved area. There is distinct destruction of the posterior portion of the base of the petrus. The part which remains presents a concave surface. The eroded area "saddle-bags" the petrous ridge and dips into both middle and posterior fossae. In the middle fossa the destructive process involving the squama reaches down to the level of the floor of the sella. In the posterior fossa it extends as far as the base of the skull.

Antero-posterior view (Fig. 7b).—The film is similar to that of the case of Woodhall and Baker. The "dark area" extends from high on the cranial vault from a point about 5.2 cm. from the midline, downward into the middle fossa below the petrous pyramid, a distance of 15 cm. There is some destruction of the base of the petrus and this section is not so dense as that of the opposite side. The dark area is more massive above and measures 6 cm. in thickness from the inner table of the skull. The remainder of the skull shows quite white by contrast. Later, from the pathology seen at operation, one

A



B

FIG. 8. (A) Case 3, J. B. Shows depression and detachment of dura deep into the middle and posterior fossae, irregular destruction of overlying skull and tooth-like projections from inner table. (B) Uneven inner surface of bone segment showing bony destruction.

could easily explain the physical appearance of the films but could not explain why the destruction of the skull could possibly be produced in the manner observed."

Dr. Law and others suggested the possibility of an hemangioma of the skull, and so diagnosed the lesion. Facts revealed at operation did not corroborate any of the preoperative diagnosis.

Operation.—March 5, 1943. Local anesthesia. The patient was placed on his left side and the right side of the head was draped to permit large exposure. As an exploratory measure, for the purpose of obtaining some information about this unusual condition, a burr hole was made through a 1" vertical incision over the center of the defect. The bone was thin, soft and cut easily with the burr. No dura was seen. The opening was slightly enlarged and with this added exposure the following observations were made. There was *no* tumor so far as could be determined. The dura was depressed, flattened, and at least 3.2 cm. from the inner table of the skull. The extradural space was filled with nothing but air. The appearance of the scalp was normal and there was no escape of air beneath scalp or pericranium. At this point we thought an hemangioma of the skull had eroded into a mastoid cell which connected with the middle ear and permitted escape of air into the extradural space. With this in mind a very large scale flap was marked off and turned down, hinging as low as possible over the ear. The flap consisted of all soft parts including the pericranium. No marking on the outer table indicated the size and extent of the lesion involving the inner table and seen on the radiographs. Therefore, the burr holes were made at points thought and hoped to be beyond the lesion. These were connected by Gigli saw and deVilbiss forceps. A large block of the skull was removed and the area inspected. Below, the involvement of the skull was far beneath the lower margin of the cranial defect created by removal of the bone block. No difficulty was encountered in the removal of this large segment of skull except that the dura was firmly adherent to the skull just at the margin of the defect. It had to be freed by slow, sharp dissection. To our utter amazement, the dura had been stripped away from the inner table deep down in the middle fossa and far back into the posterior fossa. The cerebellar dura was stripped away and exposed for an average distance of about 3.7 to 5 cm. beyond the lateral sinus. The surface of the dura was not only flattened out but was concave (Fig. 8a). The lateral sinus was readily identified in its detached depressed position. Its external dural wall was rust colored. It could be traced downward almost to its foramen of exit and back to within about 2.5 cm. from the torcula. The dura was yellow-grey and thickened. The inner table and most of the diploe were destroyed. The outer table was thinned, soft, but not perforated. The area of bone excavation was lined with a pink-red membrane about 2 mm. thick. It did not bleed readily. This membrane could be loosened but did not strip off easily. Through this membrane, numerous sharp, fine-pointed tooth-like projections stuck out like spikes. They varied in length from 3 to 7 mm. These white bony points were as sharp as rose thorns. In fact the operator "stuck" one into his gloved finger. These osseous spikes broadened at their base and were continuous with the thinned-out skull. The points were not covered with the membrane. They were glistening white and appeared like little stalactites. The picture seen was aptly described by Wernher[15] in 1873 (and quoted by Woodhall) as a "Reliefkarte eines hohes Alpenlandes" (relief map of the Alpine highlands) Fig. 8b. The bony projections in some areas were larger and blunter, especially in the mastoid region. The bone was thinnest in the middle and posterior fossae. The mastoid was excavated with cave-like holes, some communicating with other hollow, dry cavities. It was believed that the air entered the cranial cavity through one of these spaces but none could be identified at the time as to source. (Explanation of entrance of air into the extradural space will be made later.)

In the belief that the membrane lining the bone might be some kind of tumor tissue (hemangioma, etc.) the bone segment, which had been removed, was boiled for about 30 minutes. During this time the remaining involved bone of the middle and posterior

fossae and a portion of eroded inner surface of the mastoid were removed by rongeurs. The bone was soft and friable, "dry" and broke away readily. No air bubbles were seen.

After the bone had been boiled, the membrane could be scraped away, especially after the bony spikes had been removed with rongeurs. The inner table was made as smooth as possible and the segment was "pepper-boxed" with a drill. It was hoped that one would be able to draw the depressed dura, which by this time had become somewhat wrinkled due to expansion of the right ventricle, up to the inner surface of the bone segment and fix it with silk sutures through the drill holes. The dura was picked up in the forceps but it could not be lifted from the cortex. A half-inch incision

A B

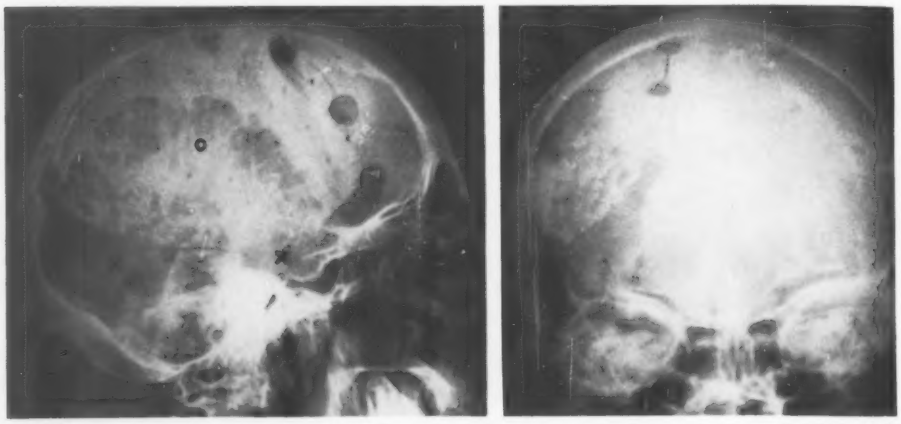


FIG. 9.—(A and B) Case 3, J. B. Roentgenograms made on March 15, 1943, 10th post-operative day, o equals bone segment fastened with rustless steel wire. x equal skull defects after removal of bone.

A B

FIG. 10.—(A and B) Case 3, J. B. Photographs of patient on 10th postoperative day.

was made in the dura to allow investigation. There were rather large, numerous cortical vessels, and the dura was firmly adherent to them. The dural incision was closed and the attempt to elevate the dura was abandoned for fear of gross damage to the cortex and its vessels.

The bone segment was placed in position and fixed with rustless steel wire, leaving a rather large dead space between the depressed dura and the bone segment. The scalp flap was replaced over the segment and the incision closed in two layers with interrupted silk sutures. A small Penrose drain was placed in the posterior angle of the incision in the hope and with the expectation that a vent for escape of the extradural air might be provided so that the dura could again come into apposition with the skull segment with the expansion of the ventricles. Compression head dressing. Specimen of bone and lining membrane sent to the pathological laboratory.

An infusion given during the operation was suspended and transfusion of blood given. The patient was returned to the ward and, after completion of the transfusion, his condition was good and his lowered blood pressure had increased to 130/80.

Immediate postoperative course uneventful. On tenth postoperative day blood chemistry and roentgen-ray films (Fig. 9A and B.). Allowed up in chair on the thirteenth day, walked on the sixteenth and discharged on the twentieth postoperative day in "excellent condition." (Fig. 10A and B).

Tentative clinical diagnosis.—Hemangioma (?) of skull. Pathologic report had not been received.

Pathologic examination.—"Acc. No. 620/43

Clinical diagnosis.—Hemangioma of right side of skull.

Source.—Pieces of bone from lesion of skull.

Macroscopic examination.—Specimen consists of innumerable small irregular fragments of bony and connective tissue measuring from a few mm. to 2 cm. across. They are received in formalin and decalcified in formic acid solution. The fragments are derived from (a) skull; (b) dura-like tissue, and (c) scrapings from inside of skull.

Microscopic examination.—Small fragments of tissue stained with hematoxylin and eosin consist of fibrous tissue and some fragments of bone. No tumor tissue is seen and no abnormality of blood vessels. In fact, as far as these sections go, the material seems to be normal dura and bone.

Received in Lab. 3-9-43. Reported 5-1-43.

Dr. L. D. Stevenson
W. C. Von Glahn, M.D."

Pathologic examination by Dr. A. A. Eggston[16] revealed that the lining of the inner table consisted of pure fibrous tissue. It probably developed from "islands" of dura remaining after the dura was stripped away from the skull.

Two weeks following his discharge the patient returned and presented considerable bulging of the scalp overlying the defect created by removal of the squama forming the lateral wall of the right middle fossa. The Resident reported this over the telephone to the author who advised aspiration with a large needle, and removal of the fluid which was probably causing the bulge. Aspiration was done, but instead of fluid only *air* was released. There was no fluid. The bulging mass subsided, but it reappeared. The patient began to drain seropurulent material from a small fistulous tract in the lower portion of the anterior suture line. He complained that when he blew his nose he felt air pass through into the cranium and out through the fistulous tract. This proved to be a fact. Drainage continued, and another small drainage opening appeared posterior in the line of incision in the occipital region. The patient had repeated frontal headaches without dizziness or vomiting. No weakness or disturbance in gait. Hypersensitiveness to loud noises and sudden events. When he held his nose and blew, air bubbles escaped through the two small openings and could be distinctly heard and seen by the examiner. This was definite proof that an intracranial opening existed through which air escaped

directly or indirectly from the middle ear or Eustachian tube. The original cause of the extradural accumulation of air producing the pneumatocele (and not hemangioma) was now more than suspected,—it was proved.

Inasmuch as the patient's general and local condition were not becoming worse, and believing that infection of the bone block had surely occurred, to be followed by partial or complete sequestration, further operative procedure was deferred.

Re-admission, October 4, 1943, *History* No. W-297 and

Physical examination.—Blood pressure 140/88. General physical examination re-

A B

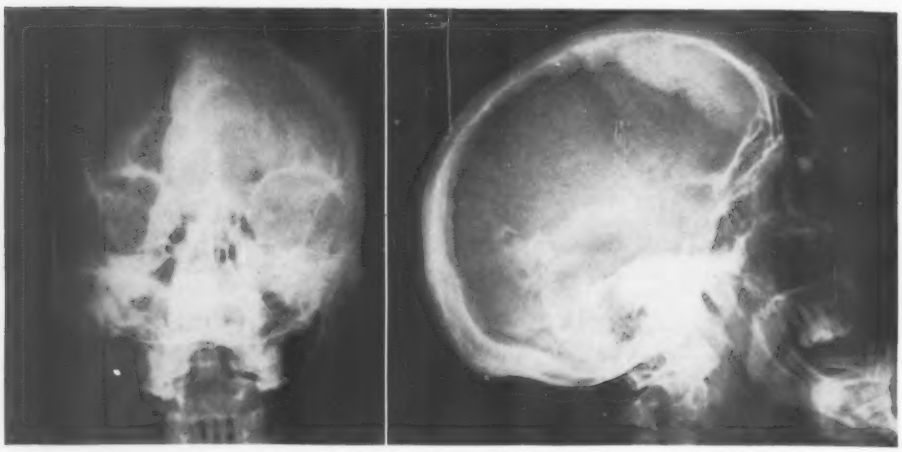


Fig. 11. (a and b.) Case 3, J. B. Roentgenograms made on September 26, 1947—about four years after operation—show reformation of bone, more evident on postero-anterior view.

veals no essential changes except that the patient has a large cranial defect on the right side extending from the anterior frontal region to the occiput, irregular surface—some soft and some resistant—throughout. The two openings of the small drainage sinuses persist.

Fundi show bilateral loss of distinction of disk margins without definite evidence of papilledema. No gross visual defects. Moderate tortuosity and dilatation of veins of the fundus. E.O.M. normal. Hearing slightly diminished on the right side and Weber test lateralizes to the right. Cranial nerves negative otherwise. Gait and station normal. No loss or weakness of motor power. No abnormal reflexes. No sensory changes. Coordination not impaired. Laboratory data negative.

Roentgenographic examination.—"*Lateral* views of the skull reveal a large cranial defect extending from a point 1" anterior to the coronal suture to the occiput and from near the midline, down and into the middle and posterior fossae. The defect is filled with thinned bone, the lower central portion of which appears viable and a coronal margin of bone along the anterior, posterior and superior borders of the defect which appears to be dead and sequestrated along a jagged irregular line. The sequestrated corona is still fixed to the skull with rustless wire ties. It was interesting to note that the sequestrated portion corresponded to that portion of normal bone comprising the upper part of the bone block, while the viable central portion corresponded roughly to the involved excavated portion seen on the films dated 3-15-43. The drill holes in the viable portion are smaller than when made and those in the sequestrated portion are larger. The margin of the cranial side has a healthy appearnce. No large collection of air is seen.

Antero-posterior view shows the bone block not so much depressed as one might judge from physical examination. The segment is almost on a level with the external surface of the remaining portion of the mastoid. No gross collection of air pockets."

The patient was prepared for operation, with two purposes in mind,—removal of the sequestrated portions of the bone segment and obliteration of air tract leading into the mastoid, or middle ear.

Second operation.—October 15, 1943. Local anesthesia.

The scar containing the two sinus openings was excised and the scalp flap made at the first operation was elevated and reflected. The central portion of the original segment about 7.5 cm. x 10 cm. was viable and firmly attached to the dura and pericranium. The dural surface, which at termination of the first operation was concave and about an inch or more below the bone segment, now was convex and of normal tension. The sequestrated portion of the segment which was fastened to the skull with steel wire ligatures was removed together with the wires. It fitted around the central viable portion like a hood on the head. Other smaller pieces were removed and granulations were gently curetted away from the dura and under surface of the flap. The intact cranial vault was not diseased. There was no osteomyelitis. Attention then turned to the search for the air-fistulous opening. The dura had again become attached firmly at all points from which it had become detached. However, low in the exposure, there was a small funnel-like depression in the extreme tip of which was a tiny pink area about the size of a pin head. It was suspected that this was the opening of the fistula through which air entered the cranial cavity. It was just external to the posterior semi-circular canal, just posterior to the superior ridge of the petrous, and in such position as to connect with the middle ear. It was in no way connected with cells of the mastoid. This funnel-like depression was filled with warm saline and the patient was instructed to "hold your nose and blow." He did, and, sure enough, air bubbled from the small pinhead-sized opening through the saline.

A muscle flap was considered, but in view of the fact that the author had never used one in the presence of infection, and not having read Woodhall's paper, this plan was discarded.

The small fistulous opening was gently curetted with a fine curette, touched with carbolic acid followed by alcohol, washed with saline, and the scalp flap was returned to position and sutured, after placing a small amount of sulfanilamide (the only sulfonamid available in that area, and penicillin was not to be obtained) over the fistulous opening and packing firmly with iodoform gauze. The patient left the table in good condition.

Postoperative course.—Dressings were changed daily. Wet Dakin gauze flats and head rolls were used. The proximal end of the iodoform gauze packing was loosened on the 6th day, gradually shortened, and the last piece was removed on the 16th day. The flap healed firmly in position without any collection of air, fluid or pus. The opening from which the iodoform gauze was removed was cored out to about the size of an 18 F. catheter, and a small rubber tube was inserted, just within the scalp and fixed with a suture. The purpose of this maneuver was to furnish a vent for escaping air in case the air fistula persisted. He was able to blow air and smoke through this tube, but only with force.

He was discharged on his 28th postoperative day, instructed to return for dressings as needed for the air vent. Should the fistula close, well and good; otherwise, further surgery might be required.

After about two and a half weeks the small tube was removed and the drainage tract closed. There was no further escape of air and no accumulation of air beneath the scalp. The patient returned to work and has been driving a Lexington Avenue bus ever since. On a recent visit to my office he stated that he is in good health, is able to do his work well, and he enters into all activities. His fine head of hair covers a mild

depression of the skull at the site of operation. Only a few areas have not become covered with bone.

Roentgenographic films (Fig. 11A and B) reveal a large defect filled for the most part with less dense bone, similar to that observed years after a cranioplasty in which tibio-periosteal transplants were used. The amount of bone present and its position is more apparent on the antero-posterior view. The margins of the defect are smooth and healthy. It is interesting to note that the coral rock appearance has disappeared from the portion of bone segment which remained viable. (Compare with Fig. 9.)

COMMENT

This case of extradural pneumatocele has many interesting features. The air remained confined to the intracranial space and had not quite perforated the skull. There was no air beneath the scalp, as has more often occurred in these relatively rare lesions. The roentgenographic findings, though bizarre, are characteristic and diagnostic. No other lesion produces such a coral rock-like picture. The author has never seen the like. The correct diagnosis was not made. Two noted radiologists, who have seen thousands of skull films, also failed to make the diagnosis because neither had ever seen a case like it. A few months later roentgenograms of a similar case were seen by the three of us and the correct diagnosis was made at once. However, the "coral-rock picture" was not present.

The pathology in the bone results from the air trapped within the cranium between skull and dura. Coughing, sneezing, exhalation, etc. force a little more air in without means of escape. Thus the air pocket accumulates.

Traumatic accumulation of air in the brain, ventricles, beneath the skin and in other places are not so uncommon. These conditions are known to all of us.

The author is at a loss to explain the uneven erosion of the skull by the air pressure. Why should the skull be almost completely destroyed in some places and have tooth-like, stalactite-like, sharp, bony projections adjoining the eroded areas? It is believed that air confined exerts equal pressure in every direction; therefore, it may be concluded that other factors influence the erosion of bone. Although the air is confined within a cavity having a rigid wall on one side and a mobile pulsating wall on the other, it is difficult to understand how this fact would influence the unequal destruction of bone. Eggston and Wolf[17] who included a radiographic print of this case in the recent monumental text: "Histopathology of the Ear, Nose and Throat," suggested that it is due to some chemical change in the bony structures of the skull by the pressure of the confined air.

On the other hand, firm fixation of the dura to the depressed cortex and cortical vessels can logically be expected following prolonged compression of the structures. It could be assumed that adhesions would form after these structures had been compressed for a long period with the added trauma of 4320 pulsations of the brain per hour.

It is not advisable to attempt to fix the dura to the bone. Separation of the dura from the large cortical vessels might produce irreparable damage.

Also it is not necessary, as proved by this case. Closure of the opening of the air fistula by means of a muscle-fascia flap was considered. It was recalled that Eggers,—and later Shenstone, had advocated a similar type of flap for closure of a bronchial fistula and had used it successfully. Since that time, many surgeons have carried out this procedure with equally good results. However, a muscle-fascia flap was not used in this case on account of the gross infection already present and the possibility of continued infection through the fistula leading into the middle ear. At the present time, when all of the sulfonamides and penicillin are universally available, the transplant-muscle-fascia flap on both should certainly be used.

Following operation the patient should be placed flat in bed, active administration of fluids should be carried out, and lumbar puncture should not be done. With this routine, the depressed dura will rise and come into contact with the skull through expansion of the ventricular system, provided a vent is established via a small rubber tube placed in the lower angle of the incision for 36 or 48 hours. It is important that all the sharp, tooth-like bony spikes be removed from the inner table; otherwise, these certainly would be thrust or driven through the expanding elevated dura-like "die eiserne Jungfrau."

The author has repeatedly regretted that he had not read Woodhall's and Baker's paper before he saw the radiographic films of the skull in this case. The final result obtained was good, but the patient would have been spared many days of hospitalization, a second operation, and the loss of many working days had the fistulous opening been found at the first operation and closed by a fascial graft, muscle-fascia flap, or both.

Case 4.—*Manhattan Eye, Ear and Throat Hospital, Ear and Throat Clinic, No. E 36857. Pneumatocele, fronto-temporary-parieto-occipital. Diagnosis made. Operation deferred. Preliminary report.*

Mrs. E. V. Age 38, white, female, housewife. Weight about 112 lbs. Examined in office, December 2, 1947.

Past history irrelevant other than for the fact that she had the usual childhood diseases including diphtheria.

Present illness.—About the middle of November in 1944 she had a cold for about three weeks and was referred by her family physician to Dr. M. Pullen. She complained of a "feeling of fullness" and loss of hearing in the right ear. No history of injury. When the cold cleared up her hearing was normal again. Dr. Pullen stated that the only abnormal finding at the time was a marked redness and injection of Shrapnel's membrane on the right. A few days later she was referred to Dr. F. M. Law for roentgenograms of the skull. At this time the unusual features of the roentgen films were first noticed. She has had no complaints or difficulties of any kind except, with an occasional cold, she has diminished hearing in the right ear, which clears up with the recovery from the cold. No headaches, no dizziness, no noises in the ear, no diminished vision. In other words her history is completely negative except for a few colds.

Appearance.—Apparently she is a perfectly normal woman in every respect. She is bright, intelligent, and gives no sign of any kind referable to the lesion seen on the roentgen-ray films. All cranial nerves are negative except for a slight peripheral right facial.

Motor and sensory.—Both intact. No areas of hypesthesia; no motor weakness.

Deep reflexes.—All present. Left upper abdominal diminished. Knee jerks somewhat increased on the left. Ankle jerks same. No Babinski.

Mouth.—On the external surface of the alveolar process on the right side there is an osteoma which has been present for about 5 years. It has barely increased in size since first noticed by the patient. It is not painful. Some thickening of the alveolar process on the left side also, but no definite osteoma. There is slight asymmetry of the face. The right side of the cheek is somewhat more prominent than the left, due to the osteoma of the alveolar process of the right side of the maxilla.

In other words, a patient who, with the exception of a few changes in her deep reflexes, is without signs or symptoms, and none commensurate with the large defect shown on the last roentgenographic film.

Roentgenographic findings.—M 2309; 12-15-44. *Lateral view* (Fig. 12a). There is

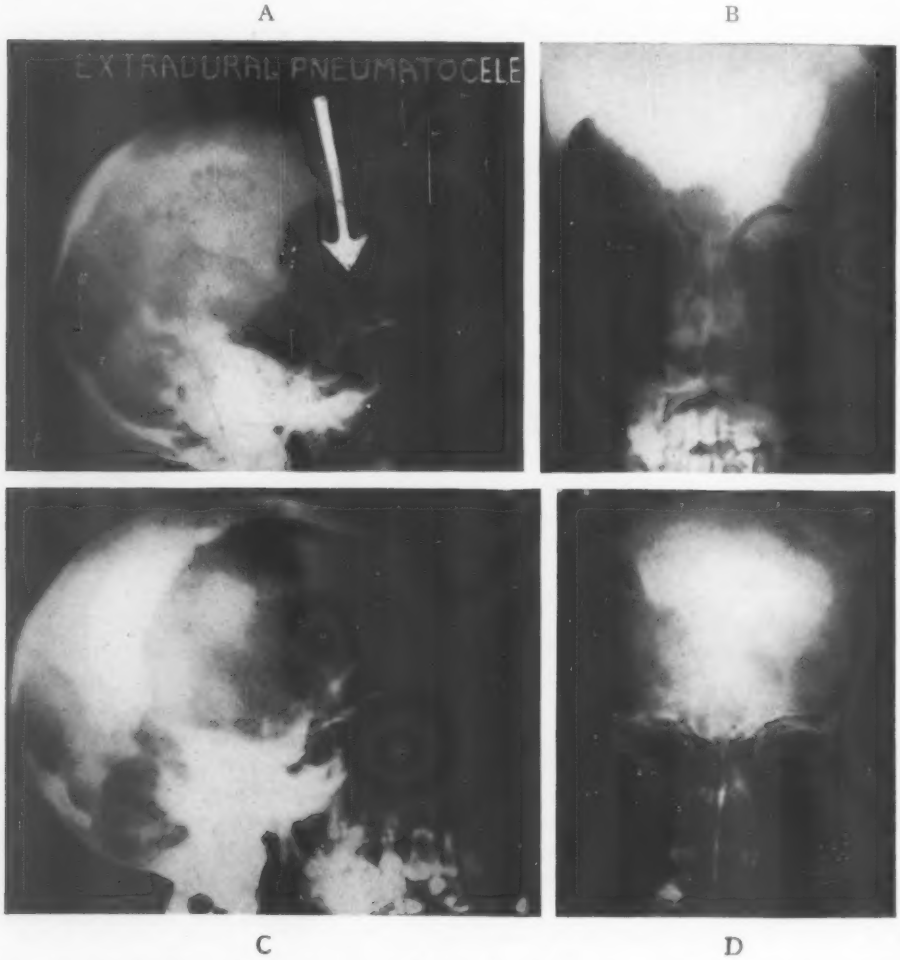


FIG. 12 (A, B, C and D) Case 4, E. V. Roentgenograms of skull showing extradural pneumatocele. (A) Lateral view showing size of defect, December 15, 1944. (B) Postero-anterior, December 15, 1944. (C) Lateral view, June 4, 1947 shows marked extension in all directions, including posterior fossa. (D) Postero-anterior, June 4, 1947 showing extension of lesion upward and to the left over frontal sinus.

a cranial defect 11 cm. in the longitudinal direction and 7 cm. in the vertical direction involving the fronto-temporal region, extending from the inner table of the skull over the frontal sinus backward in an angular fashion at a point directly over the petrous. It extends upward in the frontal region to within 3½ cm. of the inner table of the skull in the mid-frontal region along the vertex. It extends downward into the middle and anterior fossae, with gross destruction of the bone. There are a few remnants of bony streaks remaining, apparently in the subperiosteal position. The right sphenoid ridge is partly destroyed. There is some bone absorption of the entire sella. The margins of the defect are somewhat scalloped, but not to the same degree as in Case 3.

Postero-anterior view (Fig. 12B) reveals marked destruction of the petrous pyramid on the right side with but little change in the pyramid on the left side. The orbital ridge is more distinct on the left than on the right. The floor of the middle and anterior fossae is not destroyed. The dehiscence in the bone which might indicate the opening of the air fistula cannot be detected.

11-14-45 (M-6251) *Lateral view.*—The cranial defect is quite similar to the one shown on the previous films. However, it has extended farther toward the vertex. The normal bone measures 2½ cm. wide above the defect in the frontal region. Over the extreme anterior portion there is some accentuation of skull destruction. The posterior wall of the right frontal sinus is very thin being scarcely perceptible, and there is a possibility of a dehiscence in it. The destruction of the floor of the middle fossa has increased slightly. The remaining portion of the wall of the glenoid fossa is thin. Backward extension of the lesion has not increased over the petrous.

Postero-anterior view.—Extension upward of the lesion can be seen. Destruction of the right petrous is greater above than before. Destruction of the left petrous is about the same as in the preceding view with some increased pneumatization of the apex of the left petrous.

E. V. 11-4-46 (N 963) Lateral view, (almost a year later), shows marked extension of the pneumatocele, especially backward. It extends now over the top of the petrous into the posterior temporal region and far back into the suboccipital region,—almost to the torcula. There is greater destruction and pneumatization of the petrous pyramid. The floor of the glenoid fossa is thinner. The base of the skull anterior to the fossa is depressed downward and appears to be destroyed. There is greater destruction of the bone forming the right orbit. The posterior and anterior clinoids are less dense. The defect extends farther upward toward the vertex, and the frontal bone above the frontal sinus is markedly thinned out as compared with the last film. The scalloped border is more accentuated. The defect measures 17 cm. in a line from a point above the frontal sinus downward and backward into the suboccipital region and about 10 cm. in the vertical direction.

Postero-anterior view.—Greater destruction of bone behind the orbit is seen and marked absorption of bone from the supra-orbital ridge. The pneumatocele now extends across the mid line above and behind the right lateral sinus. There is greater absorption and pneumatization of both the right and the left petrous pyramid, more marked on the right.

E. V. 6-4-47 (N 4251) (seven months later.) *Lateral view* (Fig. 12c) shows extension of the lesion backward, forward and downward into the posterior fossa. In stereo, the petrous pyramid stands out like a bony crag. The defect extends to within 8 mm. of the inner table of the skull above. The floor of the glenoid fossa is almost destroyed. There is greater thinning of the frontal bone just above the frontal sinus and there is a questionable defect in the posterior plate of the right frontal sinus. There is still greater absorption of the right sphenoid ridge and the right orbital margins.

Postero-anterior view (Fig. 12d) shows the pneumatocele has extended even more toward the left and higher behind and above the frontal sinuses. The floor of the middle

fossa is more thinned out. The sphenoidal ridge is barely perceptible. There is greater destruction of the bone forming the outer half of the orbit.

The condition was explained thoroughly to the patient. She understood the possibility of perforation of the skull with extension beneath the scalp. She was not frightened. Should this complication develop, she will return for operation.

COMMENT

The position of the internal opening of the air fistula is not known. It can be determined only by operation. It is almost inconceivable that such a large extradural pneumatocele could develop with so few signs or symptoms. If and when this patient comes to operation, the findings will be reported.

The subject of pneumatocele was ably presented by Woodhall and Baker in their paper published in 1941. They reviewed the previously reported cases and gave a detailed report of a most interesting personal case. The case of Woodhall and Baker presented a communicating pneumatocele with the intracranial extradural pocket connecting with one beneath the scalp through an opening in the skull. Doubtless, if roentgenographic films had accidentally been made before perforation of the skull had occurred, the same or similar characteristics of a skull defect as shown in the author's two cases would have been noted. Woodhall and Baker did not locate the exact point of entrance of air into the extradural space, although they thoughtfully filled the suspected area of the cavity with warm saline hoping to find the "definite point of entry for the air." They observed "several small apertures passing, in all probability, into the mastoid antrum," and filled these tiny areas with bone wax. They placed a free fascial "transplant"—not a flap of muscle and fascia—over the defects previously filled with wax and brought the depressed dura up over the transplant and fixed it in position with fine black silk sutures. In this manner at one sitting they thoroughly and completely closed the opening through which the air had gained entrance to the extradural space. The patient made an uneventful recovery and was discharged on the eighth postoperative day. Their review of the literature is adequate and will not be repeated.

In a paper published in 1945 Woodhall and Cramer[18] reported a case of pneumatocele with a tantalum plate which had been used to close a traumatic defect in the frontal region. Air had found its way up through a fistulous tract from the fronto-ethmoid region filled up the entire area. They located the point of entrance of air, successfully closed the opening with a transplant and flap, replaced the tantalum plate, and the patient recovered without reaccumulation of air.

Further review of the literature since 1944 fails to reveal reports of cases similar to those described in this paper. Imperfection of the indices for the last two years may have resulted in failure to recognize similar case reports.

SUMMARY

The characteristic features of cranial defects produced by diploic extradural pneumatocele have been described. The destructive lesion results in a

defect so typical in character that diagnosis should be made before operation.

Where the epidermoid involves the cranial vault, the entire tumor mass should be removed including a segment of bone with the viable portion of the tumor attached so as to prevent recurrence. Where necessary, the dura should be resected, with the same objective in view, followed by fascia-lata transplant for the dural defect.

If the dura is not resected, curettage, boiling of bone segment and replacement are advocated. When the dura is resected, replacement of the bone segment should be deferred for several months in larger defects. Smaller ones do not require cranioplasty.

In cases of extradural pneumatocele, the involved segment of bone should be resected and the bony spicules should be removed. The intracranial extradural opening of the air fistula should be found and closed with a fascial transplant or muscle-fascial flap. Penicillin and sulfanamide should be administered. Operation should be done before spontaneous perforation of the skull occurs.

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Discussion.—Dr. R. E. Semmes, Memphis, Tenn.: In addition to the interesting material Doctor King presented I was gratified to note that I could still understand him. He has been out of Tennessee for a long time but you can realize that he is still not a Yankee.

Doctor King has encountered some remarkable material. I would like to mention some other lesions which involve the skull that also show little or no bone reaction, particularly mucoceles, cholesteatoma and epidermoids, which would be difficult to distinguish from the conditions he has shown.

Dr. Joseph E. J. King, New York (closing): I shall make no further remarks other than to present some lantern slides sent me by Dr. Barnes Woodhall, who could not be present due to illness in his family. These are slides of his case reported in his paper of May, 1941.

The condition found was very similar to my first case of pneumatocele, the main difference being that the skull had become perforated in his case, followed by a large collection of air beneath the scalp. Doctor Woodhall concluded his report as follows: "The patient's postoperative course in the hospital following operation was uneventful and he was discharged on the eighth postoperative day. No recurrence has been reported to date, although it must be admitted that, possibly in the exuberance following recovery, the patient committed mayhem on a neighbor, and has not been seen since, six months after the operative procedure."

ANATOMICAL OBSERVATIONS ON THE LUMBAR SYMPATHETICS WITH EVALUATION OF SYMPATHECTOMIES IN ORGANIC PERIPHERAL VASCULAR DISEASE*

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THE DEGREE OF SUCCESS attained in the treatment of peripheral vascular disease depends upon the ability to overcome vasospastic factors.

Leriche indicated that in peripheral vascular disease spasm is the controllable factor, and that if collateral circulation is to be readily established, there must be no vasoconstrictive influence affecting the peripheral collateral network.

Although Claude Bernard discovered vasomotor nerves in 1851, and Jaboulay directed attention toward the role of sympathetic surgery in the late nineties, interest evoked was negligible until about 1925. The work of Royle and Hunter, in 1924, was particularly noteworthy in directing attention toward surgery of the sympathetic nervous system. Since that time, appreciation of the role of the sympathetic nervous system has gradually increased. Concurrently, there has developed an increasing interest in the problem of peripheral vascular disease. The intimate inter-relationship of the two systems, both functionally and pathologically, has become well recognized. Certain clear cut concepts regarding the sympathetic system have emerged. Concepts regarding vascular disease have not been as well delineated.

In the final analysis—this diversity exists not because of differences in interpreting the underlying vascular lesion, but because of variables in the therapeutic approach to associated factors of which the sympathetic nervous system is of prime importance.

Disturbance in the normal amount of circulating blood in peripheral vascular disease is dependent upon two factors, either or both of which may be present: (1) obliterative structural change; (2) abnormal spasticity. In spastic conditions, belonging in the category of Raynaud's disease, that fail to respond to conservative therapy, sympathectomy remains the procedure of choice despite occasional disappointing recurrences. In addition, the importance of sympathectomy in thromboangiitis obliterans seems to be well recognized and generally accepted. However, considerable difference of opinion exists regarding the rationale of sympathectomy in degenerative vascular disease.

Alteration in the blood supply to tissue is an inevitable process of body involution. It is one phase of our biologic heritage. When certain tissues become involved, out of all proportion to the remainder of the body, physiologic and functional derangement is the inevitable consequence.

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

Well selected cases of occlusive arterial disease uniformly show a satisfactory response to ganglionectomy. These patients, however, should be subjected to such a procedure only after cautious evaluation, and after it has been determined that conservative therapy will not accomplish the degree of improvement anticipated by ganglionectomy.

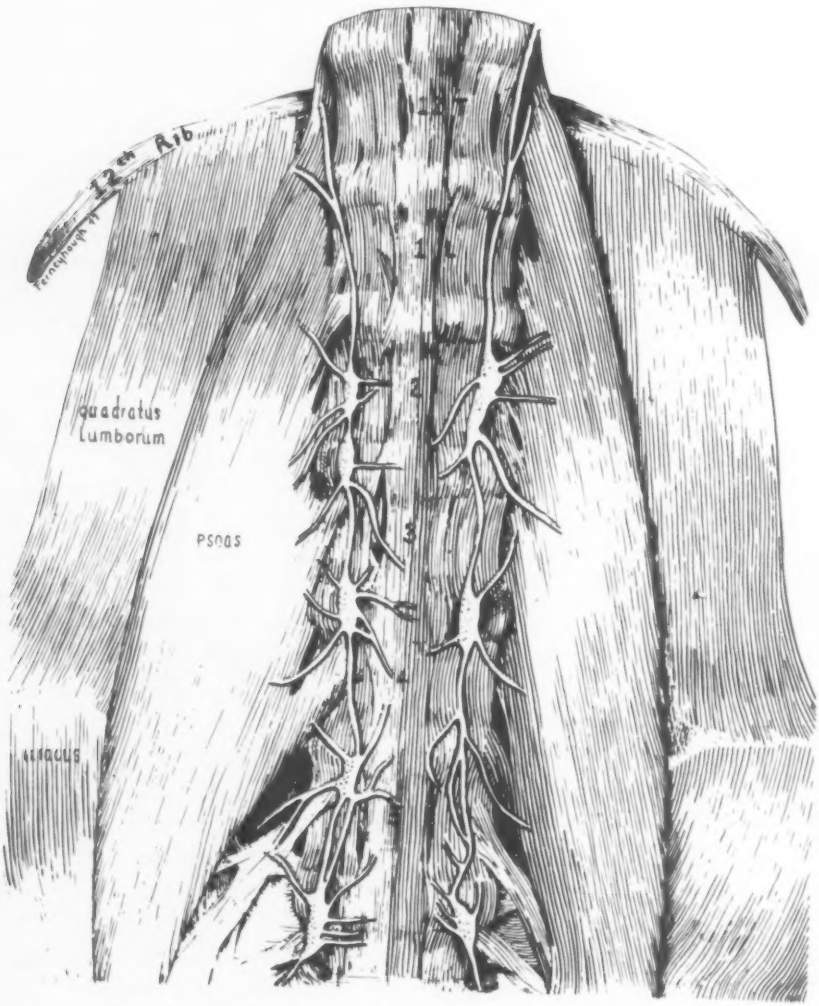

FIG. 1.—Lumbar sympathetic system, Joseph Swan, 1825.

Sympathectomy reduces the potential pathologic vasoconstriction of the individual, without abolishing physiological power. Theoretically, all cases of peripheral vasospasm should be relieved by sympathectomy. Clinical and laboratory observations, however, have confirmed the impression that there are several types of vasospasm and that the autonomic nervous system does not completely control the dilatability of the peripheral arterial system.

As early as 1919, Leriche, in his monographs, made the statement that

he intervened surgically in cases of senile arteritis at the earliest possible moment. He advocated periarterial sympathectomy, arteriectomy or lumbar sympathectomy according to the particular case. The latter operation, which is based on sound anatomic and physiologic considerations, has gradually become accepted as the procedure of choice.

In this clinic, sympathectomies in degenerative organic vascular disease

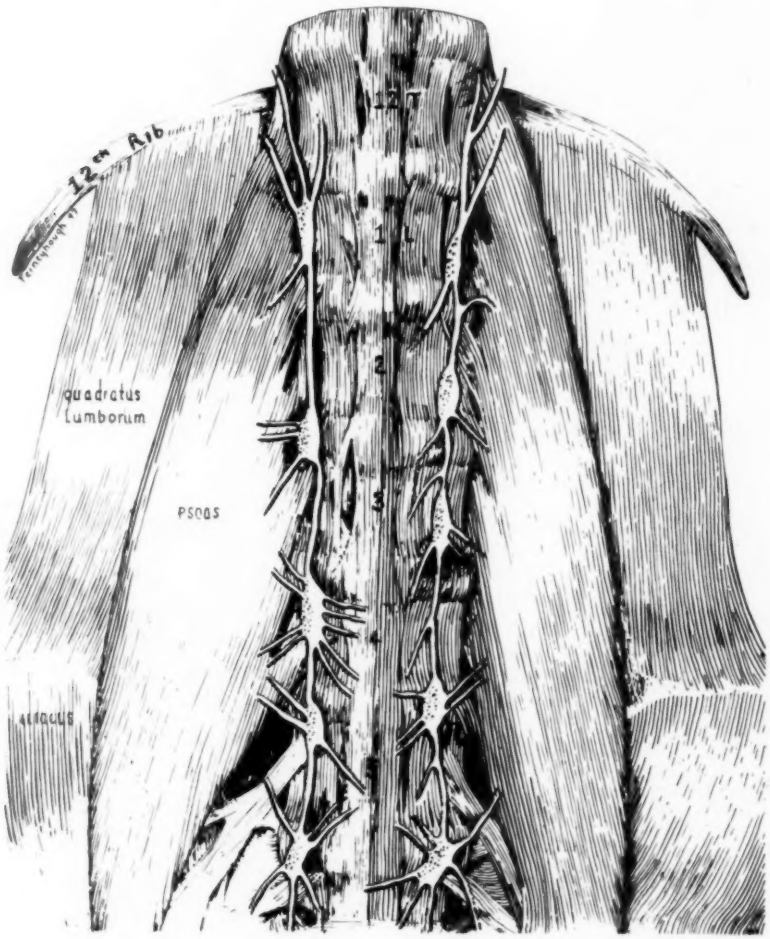

FIG. 2.—Lumbar sympathetic system, Ludovic Hirschfeld, 1866.

have been performed since 1939. The operation is now limited to those patients with demonstrable associated vasospasm, not responding to conservative measures, including such procedures as paravertebral blocks. In this study, a total of 150 patients have had either single or bilateral lumbar ganglionectomies.*

*Case Reports from University Hospital, Baltimore, Maryland, and the Baltimore City Hospitals, Baltimore, Maryland.

Analysis reveals that 46 patients (30.66%) were discharged from the hospital as "improved". An additional 12 patients presumably had lumbar ganglionectomies performed. Pathologic examination of the tissues from this group did not reveal evidence of sympathetic nerve tissue or ganglion, and therefore these patients were not included in this study. A requisite for inclusion of the 150 patients studied in this group, was pathologic confirmation

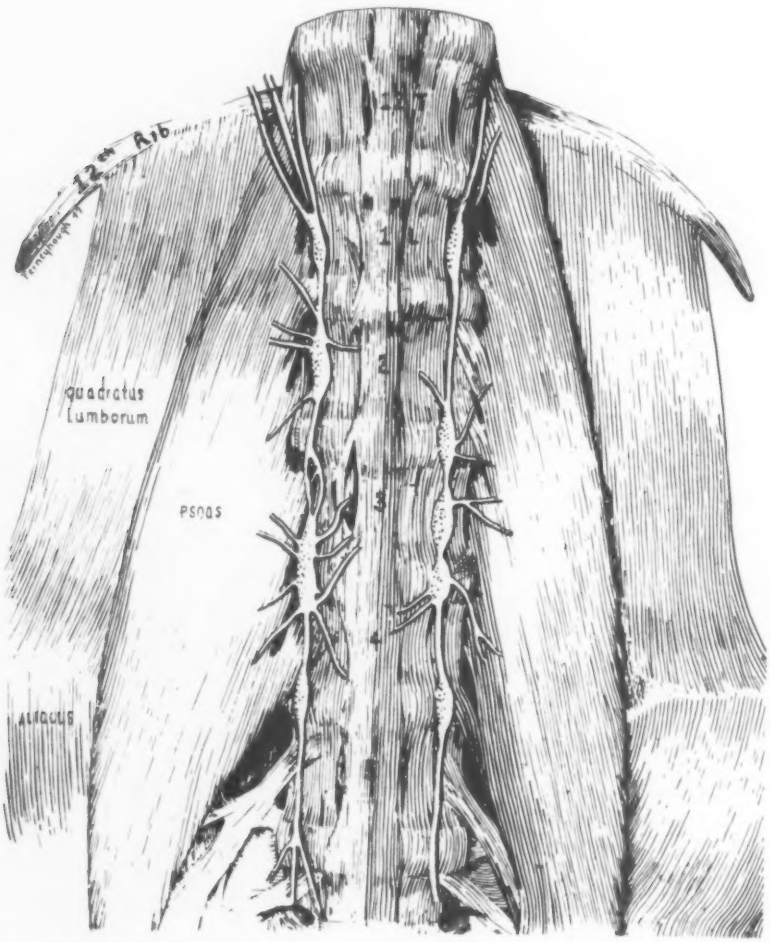

FIG. 3.—Lumbar sympathetic system, A. Hovelacque, 1927.

of sympathetic nerve tissue and ganglion. It is believed that with the exception of one case noted below, removal of tissue not consisting of the sympathetic chain represented unfamiliarity with its variations, rather than congenital absence. In a few instances, it was difficult to evaluate the degree of improvement and whether or not it was attributable to the ganglionectomy itself, or to hospital adjunctive care, and restriction of activities. Follow-up revealed recurrence of symptoms in 6 months to one year in ten cases, of such degree

as to require adjunctive therapeutic measures. These results are somewhat disappointing. However, it is believed that additional analysis will reveal that many of the disappointments were due to controllable factors, and were not related to the rationality and efficacy of sympathectomy.

Sympathectomy in degenerative obliterative vascular disease is usually advocated for one or several of the following reasons: (a) Relief of pain and

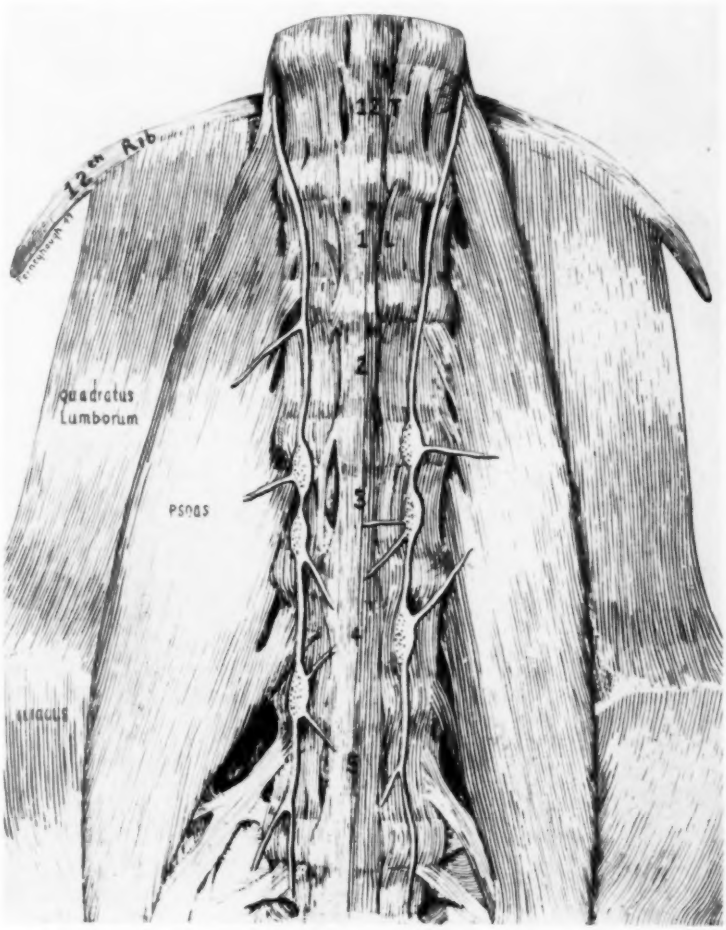

FIG. 4.—Case 8: No ganglion on either side of L-1 and almost all of L 2. Three ganglia appear on either side, below the level of the intervertebral substance of L 2 and L 3.

improvement of collateral circulation; (b) Avoidance or postponement of amputation; (c) Extending the safe level in cases of inevitable amputation; (d) Simplicity and ease of performance.

RELIEF OF PAIN AND IMPROVEMENT OF COLLATERAL CIRCULATION

In our experience, relief of pain is unpredictable. In vasomotor disturbances, spasm is a major pain factor. Studies should always be made to differen-

tiate the degree of organic occlusion and associated vasospasm. This is important, in order to establish whether or not the procedure is warranted; whether there is a reasonable chance of relieving pain; and as a prognosis index. In this series, it was noted that only 77 of the 150 patients had what are considered minimal vasomotor studies. In other words, 73 patients had

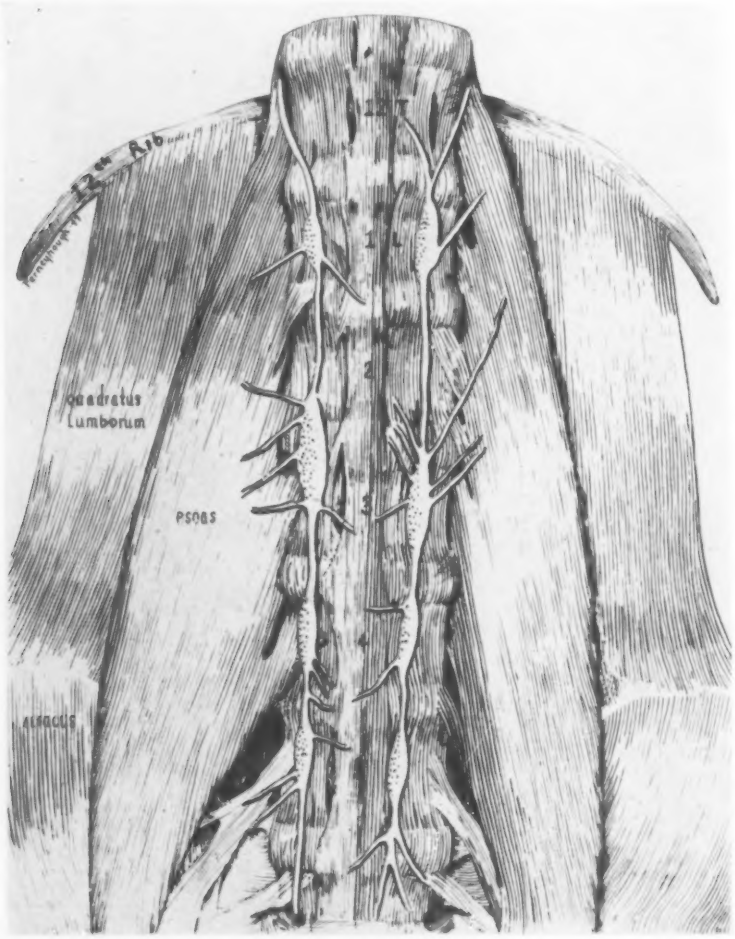

FIG. 5.—Case 11: Four ganglia more or less symmetrically placed on the two sides, and in corresponding relationship to the lumbar vertebrae. Frequently, this is thought to be the usual arrangement, but in this series of dissections it was the least usual.

ganglionectomies without adequate vasomotor studies. This represents a rather poor selection of cases. It is realized that the procedure was advocated in an effort to improve an apparently hopeless condition. However, to avoid casting doubt on an otherwise effective procedure, it should be reserved for those cases in which there is reasonable chance of success.

Sympathetic novocain block was performed on 77 patients of the 150

patients in this series, and an attempt was made to evaluate the possible effects of ganglionectomy. No attempt was made to establish a real criteria for the operation in 73 cases. Although sympathetic procaine block will not always give reliable information regarding the probable results of sympathec-

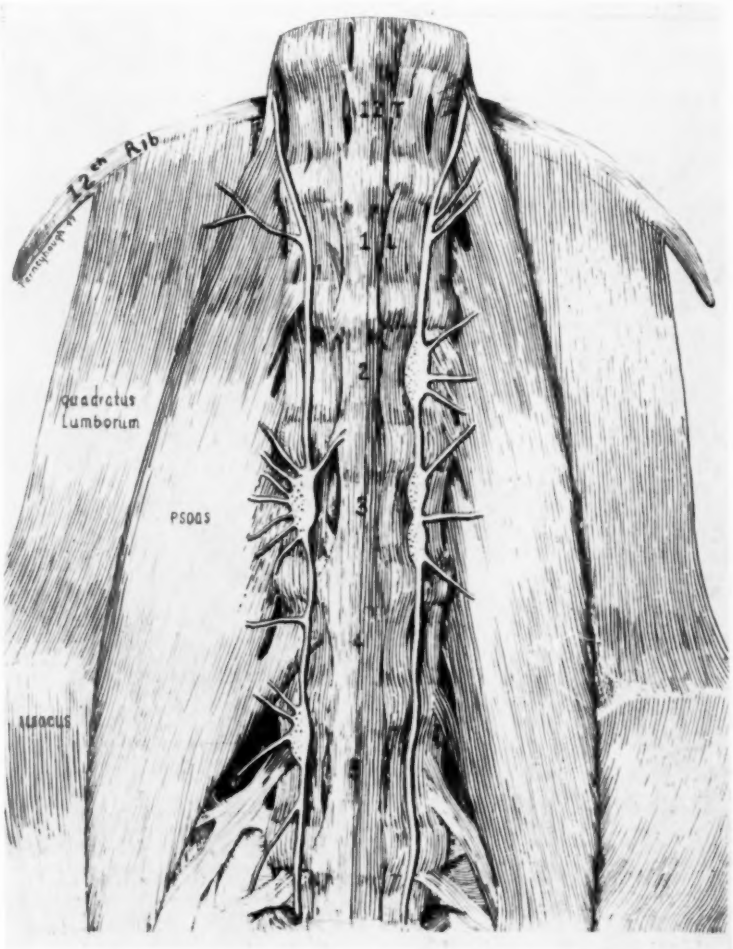

FIG. 6.—Case 12: No ganglion overlying L 1 on either side; no ganglion below the level of L 3 on the left.

tomy, it is believed, that it, or its equivalent, should be employed as a basis of evaluation. If positive evidence is not gained, it may at least give a negative type of evidence, as demonstrated by temperature drop. De Takats has indicated that digits revealing temperature drop, may become gangrenous following sympathectomy.

Efficacy of sympathectomy in correcting ischaemia, depends upon the capacity of the collateral circulation to improve, by elimination of persistent or intermittent vasoconstriction and maintenance of vasodilatation.

Gask and Ross pointed out that "if after sympathectomy a considerable degree of tonus appears in the denervated vessels, the condition of the patient may be more precarious than it was before the operation, since the vessels are no longer under the control of the nervous mechanism. It is

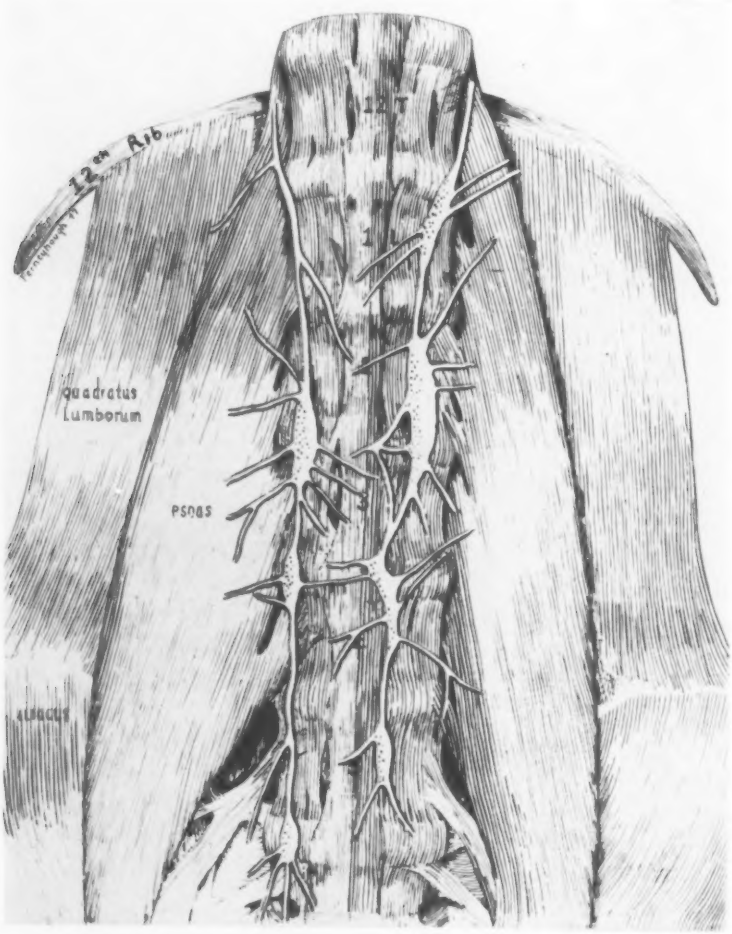

FIG. 7.—Case 13: Rami radiate in all directions; communicating rami from 2nd ganglion on left fuses with common trunk. Note well defined communication between right and left trunks, at the level of the 3rd and 4th intervertebral substance. This is not an unusual occurrence.

believed that vasomotor nerves exhibit the phenomena of reciprocal innervation, vasodilatation involving an inhibition of vasoconstrictor tonus.'

AVOIDANCE OR POSTPONEMENT OF AMPUTATION

Fifty-six patients required amputation of varying degrees, 13 involving the foot or less; and 15, of the leg, below the knee. Twenty-eight amputations were supracondylar in character. Six patients had bilateral amputation.

All of these amputations were performed within two months following ganglionectomy.

EXTENDING THE LEVEL OF INEVITABLE AMPUTATION

The average amputation age was 56.8 years. The average age for the entire series was 52.5 years. Fifty per cent of the amputations performed were supracondylar in character. With advanced organic degeneration, slight vasospasm and loss of elasticity of collateral vessels, it is not probable that sympathectomy will extend the level of safe amputation, any more effectively than general supportive measures.

SIMPLICITY AND EASE OF OPERATION

There were nine deaths under 10 days, a mortality rate of 5.5%. There were eight additional deaths within 30 postoperative days. All operations were of the retroperitoneal type. In one patient not included in this statistical study, the ganglionated chain could not be identified due to extensive inflammatory changes. These changes were apparentaly secondary to repeated paravertebral blocks. Pathologic examination of tissue removed from an additional 11 patients, also not included in this statistical study, revealed either lymphatic or fibrous tissue and not sympathetic nerve tissue. These findings do not tend to confirm the statement that has been made that lumbar ganglionectomy should be performed in questionable cases because it is a comparatively simple and easy type of procedure.

This report represents the collective efforts of various surgical residents, as well as visiting surgeons. In attempting to evaluate the end results, individual variations in technic and incompleteness of operation may account for some of the disappointing results. Also, unless there is an awareness of the extremely varied characteristics of the lumbar sympathetics, portions of the chain will frequently be overlooked.

In attempting to clarify the indications for sympathectomy, and to simplify the operative problem, proper attention has not been focused on these variations and the criteria for adequacy of operation. Access to, and adequate exposure of an anatomic structure, is but one phase of the important problem of surgical attack on the structure itself.

The lumbar sympathetic chain usually is diagramatically represented by a ganglion resting on the body of each of the first four lumbar vertebrae on the right and left sides. Discussion is frequently limited to the chain's relationship with the vena cava and aorta respectively. In our experience, the lumbar sympathetic chain has proven the most variable portion of the sympathetic system, and one of the most variable structures in human anatomy.

Swan, in 1825, indicated that on the right side, the first lumbar sympathetic ganglion appears at the level of the beginning of the second lumbar vertebra; the second ganglion at the lower part of the second lumbar vertebra; the third ganglion between the third and fourth lumbar vertebrae, and

the fourth ganglion between the fourth and fifth lumbar vertebrae. On the left side, he stated that there were but two ganglia, the first ganglion located as on the right, while the second ganglion appears over the upper part of the fourth lumbar vertebra.

Hirschfeld, in 1866, showed four ganglia on each side, with the fourth

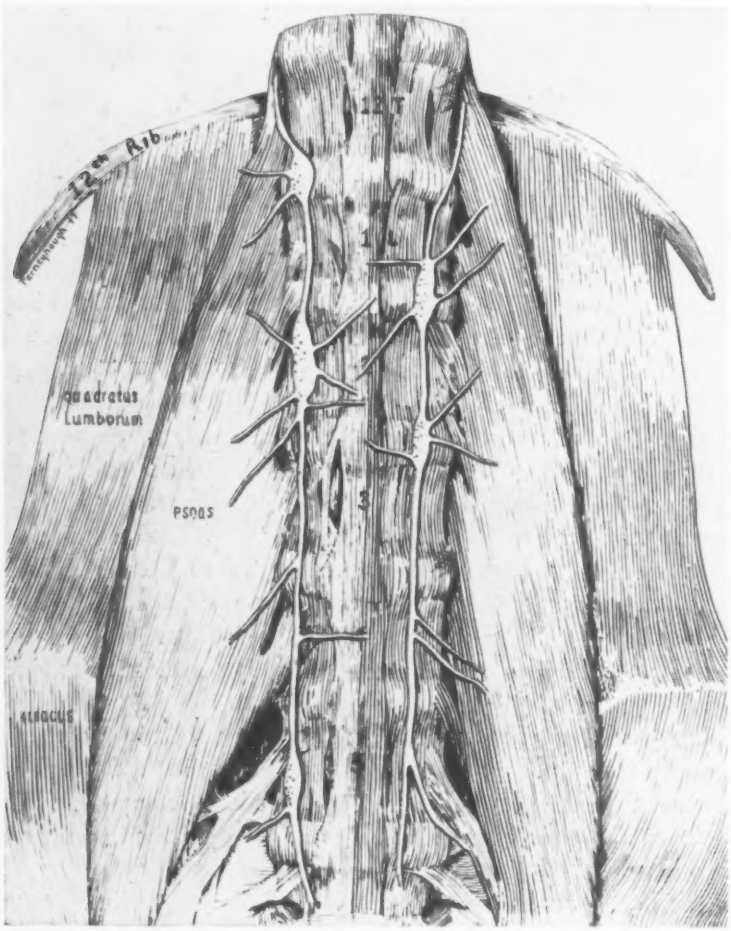

FIG. 8.—Case 14: Large rami coming off the sympathetic chain without presence of ganglia, over region of 4th lumbar vertebra. This is not an unusual occurrence.

ganglion appearing on the upper part of the body of the fifth lumbar vertebra.

Hovelocque, in 1925, placed the first lumbar ganglion, on the right side, on the body of the first lumbar vertebra; the second ganglion on the middle of the second lumbar vertebra, with three cephalad and one caudad rami; the third ganglion on the lower half of the third vertebra and intervertebral substance, and the fourth ganglion on the intervertebral substance of the

fourth and fifth lumbar vertebrae. In his illustrations, he shows four ganglia on the right and five on the left.

Pearl, in describing a muscle-splitting extraperitoneal lumbar ganglionectomy, makes the statement that the rami of the second ganglion are directed

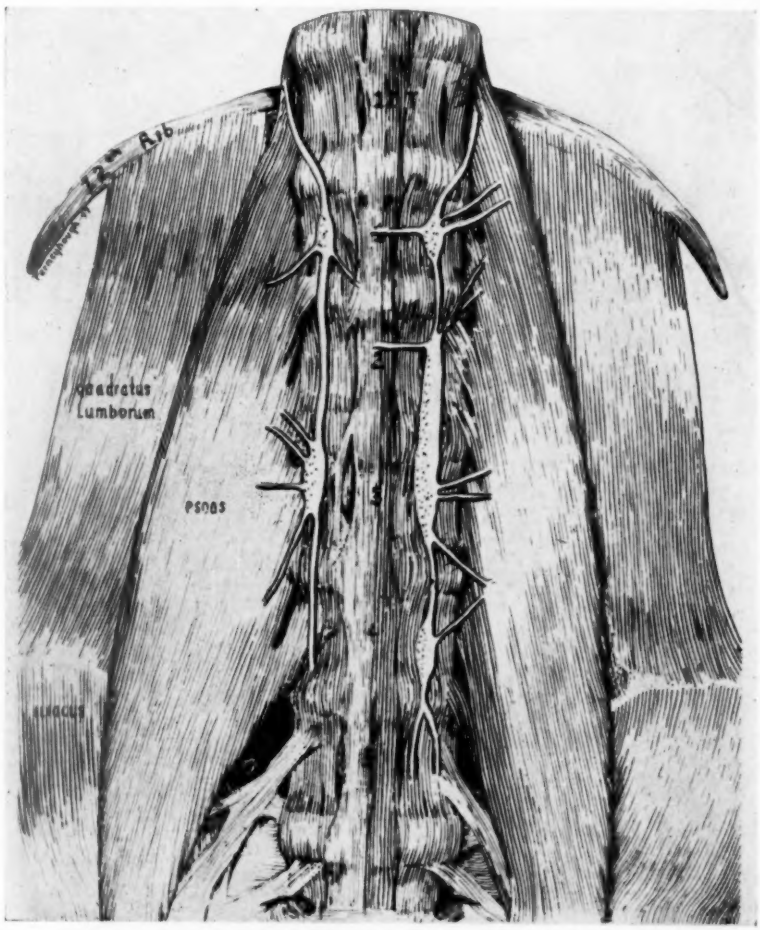

FIG. 9.—Case 17: Single ganglion present, 1st L. vertebra, right and left sides; frequently they are absent, and one sees only the thoracic trunk passing from lateral to anterior with a communicating branch. The large elongated ganglion on the left covers nearly all of lumbar vertebrae 2 and 3.

cephalad, whereas those of the third and fourth ganglia are directed caudad or transversely.

Livingston, in 1937, expressed the opinion that variations in the lumbar region are so common as to render it almost absurd to state that "the second, third and fourth lumbar ganglia were removed". He states that, what is meant, is that the surgeon removed as much of the chain as he could conveniently get at, from as near the usual location of the first lumbar

ganglion to the point where the chain passed beneath the iliac vessels into the pelvis.

Atlas states that "because of erratic fusion of lumbar sympathetic tissue, it is impossible to designate lumbar ganglia on a numerical basis with any degree of accuracy". He also states that "because of unpredictable varia-

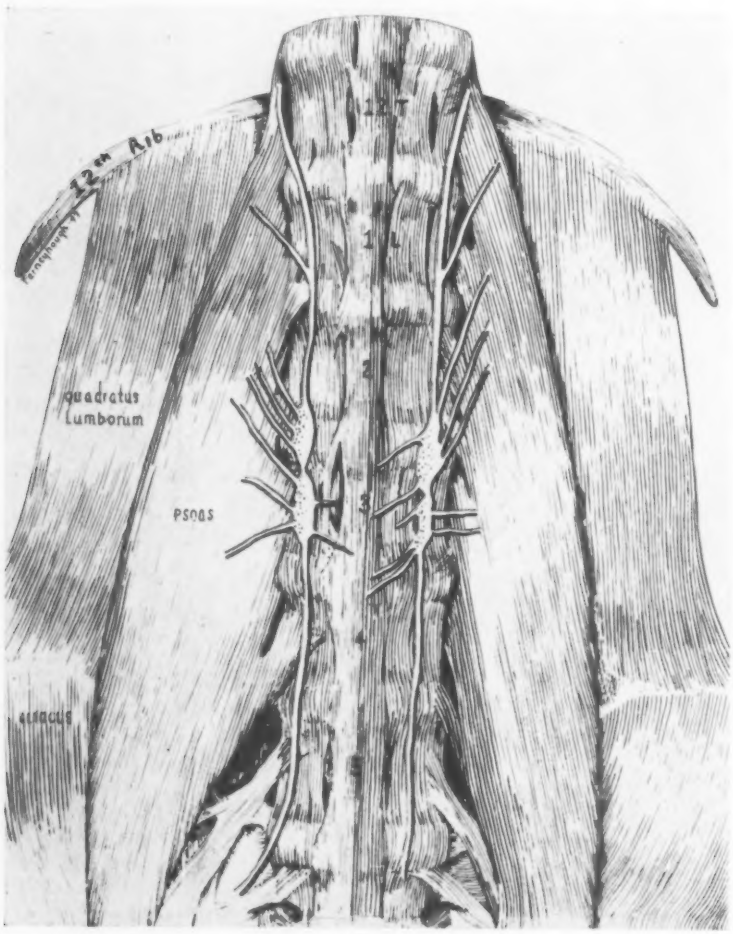

FIG. 10.—Case 18: Ganglia fused; two on each side.

tions in the number and position of the lumbar sympathetic ganglia, it is preferable to describe a lumbar sympathectomy not on the basis of which ganglia were removed, but from the anterolateral surfaces of which vertebral bodies the trunk was resected".

Gask and Ross state, "there are four lumbar ganglia, and as the fourth usually lies on the pelvic brim behind the common iliac vessels, it is not removed in the operation commonly practised for sympathetic denervation of the leg". They believe, "the sympathetic supply to the leg has its con-

nector cells in the lowest three thoracic and the upper three lumbar segments, the preganglionic fibres passing out in the six lowest white rami communicantes, and ending in the second, third and fourth lumbar, and in the sacral ganglia. The grey rami communicantes from the second lumbar ganglion downwards contain postpanglionic fibres which are carried to the periphery by way of the lumbar and sacral plexuses of the spinal nerves. It is therefore clear that if the second, third and fourth ganglia and the intervening portions of the trunk be removed, the excitor cells to the lumbar nerves and the preganglionic fibres to the sacral nerves will be removed or divided, and sympathetic denervation of the leg will thus be achieved."

Lumbar sympathectomy, for effectiveness, should be physiologically, as well as anatomically complete, and at the same time not be associated with unpleasant complications. J. C. White has shown that bilateral resection of the first lumbar ganglion is usually followed in male subjects by paralysis of the ejaculatory mechanism and sterility. In cases of simple vascular spasm this ganglion should be spared.

Livingston feels that the third lumbar ganglion is the "central point" for surgical attack, while Atlas believes that if incomplete denervations are to be consistently avoided, the exposure of the sympathetic trunk should be carried as high as the intervertebral disk between the second and third lumbar vertebrae before the trunk is divided and stripped.

The latter also believes that if the sacral ganglia are left undisturbed, a predominantly preganglionic denervation of the blood vessels of the foot is obtained. Sensitization of arteriorlar musculature to circulating adrenaline which follows destruction of its postganglionic innervation is thereby avoided, and the denervated arterioles in the foot remain dilated. Since preganglionic fibers rarely join the sympathetic trunk below the level of the second lumbar vertebra, the simple maneuver of dividing the trunk at the upper pole of the third lumbar vertebra interrupts the flow of vasomotor impulses to those blood vessels of the lower extremities which receive their innervation through the branches of spinal nerves L. 3, 4, 5; S. 1, 2 and 3.

In a series of 19 anatomic studies, we could not find a sympathetic ganglion on the first lumbar vertebra on the right side in nine instances, and on the left, in six instances. A ganglion was not found on either side of the first lumbar vertebra in four instances. The number of lumbar ganglia found ranged from two to five; the average number of ganglia on each side being about three. The rami to a ganglion varied from two to seven; dissections were gross in character, and it is probable that smaller filaments were destroyed without identification. In the entire series, no two chains were similar, and no pattern of variation could be established. There were no predominant characteristics for either sex. The age range studied was from a stillborn male to an 83-year-old female.

The direction of the rami for individual ganglia varied from cephalad, and transverse to caudad. In our opinion, identification of an individual ganglion

by direction of its rami is unreliable. Lumbar veins passing anterior to the sympathetic chain were an infrequent occurrence.

The most constant ganglion, on both the right and left side, was found on some portion of the second lumbar vertebra, usually its lower third, and frequently crossed the intervertebral substance on to the body of the third lumbar vertebra. Its rami, both in number and direction, were extremely varied. It was invariably the largest of the lumbar ganglia, and when palpating for the sympathetic chain, the most easily identified.

As a matter of practical operative importance, it is suggested that usually the body of the fourth lumbar vertebra can be identified by the overlying aorta bifurcating into the common iliacs. In a similar manner, the first lumbar vertebra can be identified by the medial lumbocostal arch. If a ganglion is present on the body of the first lumbar vertebra, it is usually not seen, since it is covered by this structure. Exposure of it is unnecessary, since its removal is not indicated. For adequate denervation, sympathetic tissue should be removed between these two points. Sympathetic tissue overlying the fourth lumbar vertebra is usually obscured by the common iliacs. Its removal is often hazardous, and under such conditions, not advisable.

SUMMARY

1. The inter-relationship of the sympathetic nervous system and peripheral vascular disease is reviewed.

2. The end results in a series of 150 patients with lumbar sympathectomy are analyzed.

3. Probable factors contributing to many of the disappointing results are discussed.

4. Proper selection of patients for this procedure, anatomic variations and adequacy of sympathetic denervation are emphasized.

CONCLUSION

1. Lumbar sympathectomy adequately executed, in properly selected cases of organic peripheral vascular disease, is an adjunctive procedure of merit.

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CORRECTIONS

In the January, 1948, issue of the ANNALS OF SURGERY, the last paragraph of Dr. J. William Hinton's article "One-stage Resection and Anastomosis of the Colon" on page 12 should read "Proponents of multiple-stage colonic surgery state that the low mortality possible with this operation outweighs its disadvantages; Rankin[26, 27] and Lahey.[17] Cheever[5] in 1931, reported comparable series of these cases and showed that in their hands, onestage resection, with anastomosis and a proximal vent for *decompression* had a lower mortality than the exteriorization procedures."

* * *

In the March, 1948, issue of the ANNALS OF SURGERY, the sentence beginning on line 36 of Dr. Hayes Martin's article "Juvenile Nasopharyngeal Angiofibroma" on page 534 should read "We suspect that Shaheen's cases of 'malignant transformation' were actually malignant nasopharyngeal *cancer* and not nasopharyngeal fibromas in the beginning."

THE EFFECTS OF PRISCOL (2-BENZYL-4, 5-IMIDAZOLINE HCl) ON PERIPHERAL VASCULAR DISEASES, HYPERTENSION AND CIRCULATION IN PATIENTS*†‡

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Adrenolytic and sympatholytic drugs have been known and investigated for many years. By blocking action of adrenalin or blocking effector sympathetic pathways these drugs might aid study, diagnosis, or treatment of paraganglioma, pheochromocytoma, peripheral vascular diseases or hypertension. Currently, three drugs are receiving clinical trial. Etamon (tetraethylammonium chloride or bromide) is essentially a ganglionic blocking agent but is not adrenolytic (Acheson and Moe[1]). By blocking ganglia other than those of the sympathetic nervous system, it may produce abnormal function of the eye, bladder, and gastro-intestinal tract. Dibenamine (dibenzyl beta-chlorethyl amine hydrochloride), Nickerson and Goodman,[2] and Priscol (2-benzyl-4, 5-imidazoline HCl) more specifically block sympathetic motor pathways acting apparently at their termination in smooth muscle. These drugs are adrenolytic. Dibenamine has a more prolonged action than Priscol but must be administered intravenously. Effects of Priscol last three to eight hours and the drug may be given orally, intramuscularly, or intravenously.

Hartman and Isler[3] first reported Priscol in 1939, stating that of a group of phenyl-substituted alkyl imidazolines examined, it produced greatest depression of blood pressure. The same year Meier and Mueller[4] reported that Priscol dilates vessels of mucosa and skin but that vasodilatation is more pronounced in extremities. Also, they demonstrated that Priscol and adrenalin together produced lowering of blood pressure. Meyer[5] later clarified and proved adrenolytic properties of Priscol. Chess and Yonkman[6] demonstrated that although Priscol was adrenolytic as judged by reduction of blood pressure, it was not adrenolytic or sympatholytic with respect to all cervical sympathetic functions studied. Yonkman et al[7] also demonstrated stimulation of ileum of dogs, a cholinergic response blocked by atropine. Ahlquist and Woodbury[8] observed that Priscol inhibits pressor and constrictor effects of several sympathomimetic drugs but has little action on their depressor or dilator effects. Ahlquist, Huggins, and Woodbury[9] subsequently report that Priscol acts primarily as a sympathomimetic agent producing peripheral vasodilatation, cardiac stimulation, coronary vasodilatation, increased cardiac out-

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*Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

†Acknowledgment is expressed to Raymond Chittum, William Trigg, Doris Lockamy, and Doris Morgan for assisting in this study.

‡Supplies of Priscol and a grant in aid given by Ciba Pharmaceutical Products Incorporated, Summit, New Jersey.

put and some inhibition of the gastro-intestinal musculature. They describe occasional elevations of blood pressure and believe that changes of pressure depend upon a balance between peripheral vasodilatation and increased cardiac output. In animals they describe histamine-like properties and also acetylcholine-like effects. They conclude that Priscol is an effective sympathomimetic anti-pressor and adrenolytic agent. Further experimental studies will not be reviewed except to state that Hatt[10] using the Starling heart-lung preparation found that damaging doses of Priscol were one hundred times greater than those used to reduce blood pressure. Our own experiments[11-14] confirm adrenolytic and sympatholytic properties in dogs and man. Current experiments also show that neurogenic hypertension in dogs is occasionally reduced but rarely brought to normal even by large doses. Pituitrin will increase blood pressure after reduction with Priscol.

There are many reports of clinical use of Priscol in the European and South American literature. Only a few will be quoted. Zothe[15] demonstrated decrease of circulation time to the toe. Siedek[16] calculated cardiac output in 14 patients and usually found moderate increase. Lipross[17] reported increase of finger and toe temperatures in patients after Priscol[18] and abolition of skin temperature gradient of arms and legs. De Gennaro and Bertazzi[19] demonstrated increase of gastric motility and hastening of gastric evacuation. Luft[20] compared effects of several drugs upon skin temperature of healthy individuals, with effects in two patients with thromboangiitis obliterans and one with arteriosclerosis. He found that Priscol caused greatest increase of temperature. Other observers have reported using Priscol for frostbite, Shroder;[21] Raynaud's disease, Kohlmayer;[22] diabetic arteriosclerosis, Schietz;[23] and hyptertension, Singer.[24] More than 40 additional authors have reported varying degrees of success using Priscol for a wide variety of circulatory disorders. Frequently relief from pain associated with vascular disease has been described.

This report deals with results of clinical investigation during the last two years. No patient has been treated longer than nine months, but many are continuing treatment.[25, 26] Material will be presented in three sections: (1) clinical observations during testing or treatment of peripheral vascular disease; (2) testing or treatment of hypertension; and (3) general effects of Priscol on circulation.

Experimental and early clinical evidence indicated advisability of using larger dosage schedules than previously reported. Except for time of onset and maximum response little difference in total effect has been observed between administration by oral, intramuscular, or intravenous routes. Amounts of Priscol administeerd to some patients with peripheral vascular disease described in section 2 now seem excessive and amounts administered in hypertension, section 3, may be too low. To facilitate interpretation schedules now believed approximately correct will be presented. Twenty-five to 75 mg. intravenously or intramuscularly apparently adequately tests patients with peripheral vascular disease and 25 to 50 mg. orally every three or four hours

apparently maintains maximum therapeutic effects. Tests for patients with hypertension have been based upon intravenous injection of 50 mg. followed an hour later by another 50 mg. and usually followed after another hour by injection of 100 mg. Dose schedule for treatment of hypertension varies but is usually gradually increased to a maximum of 75 mg. every two hours. Since lowering of blood pressure has not constantly followed test or treatment, effective dose range or potential value for treatment of hypertension has not been established.

Complications or side effects will be presented in advance of clinical reports. Twenty-five to 75 mg. as an initial dose produces a sensation of crawling in the skin, a feeling of warmth of face and ears, a sensation as if hair were rising, a chilly sensation with development of "goose flesh," and occasionally apprehension. Patients may also describe increase of heart rate. Occasionally nausea occurs and, rarely, vomiting. Continued treatment, using 25 to 75 mg. every two to four hours is usually associated with fewer or milder symptoms. Test doses as high as 200 mg. per patient, accentuate the above symptoms and also produce disability from postural hypotension. Occasionally such doses cause audible peristalsis, dizziness or a far-away feeling, sweating, congestion of the nose, or headache.

EFFECT OF PRISCOL IN PERIPHERAL VASCULAR DISEASE AND RELATED CIRCULATORY DISORDERS

Forty-three patients with vascular disease or related disorders of extremities received Priscol. Six had Raynaud's disease; 15, arteriosclerotic obstructive vascular disease; six, thromboangiitis obliterans; three, popliteal aneurysms; seven, extremity pain loosely grouped as causalgia; four, phlebitis; and two, acute ischemia. Observations varied from simple testing of the effects of single doses to study of results of prolonged treatment.

Results of administration of similar doses of Priscol orally, intramuscularly, or intravenously were compared in ten of these patients with peripheral vascular disease. Intravenous injection produced generalized vasodilatation within two minutes. Intramuscular administration produced vasodilatation within ten minutes and oral within half an hour. Although delayed flushing after oral administration was less intense than that produced by intravenous or intramuscular administration, its lasting or total effect was usually equivalent.

1. *Raynaud's disease.* Six patients gave histories and presented clinical criteria compatible with diagnosis of Raynaud's disease. Phasic color changes of digits of hands and feet occurred spontaneously and were produced by exposure to cold or by emotional stress. Blanching, rubor, and cyanosis occurred in each patient, often simultaneously in separate areas of fingers or toes. Rubor or cyanosis was produced by placing hand or foot in ice water and blanching by exposing the patient to refrigerator temperatures. Not included are any patients complaining solely of reddening or pallor of the hands on exposure.

Two patients had undergone sympathectomy of the upper extremities.

One had symptoms seven years. Two years after onset of symptoms, a preganglionic sympathectomy was performed on the left and a ganglionectomy on the right. Some scleroderma had developed before sympathectomy and ulcers had appeared. Improvement of either hand lasted less than a year and trophic changes were progressing. Because of persistent pain and ulceration this patient was tested and treated with Priscol. Two hundred milligrams intramuscularly increased temperature of the fingers and toes four degrees centigrade. The patient could not tolerate immersion of the hands in ice water before Priscol. Afterward he kept his hands submerged five minutes without pain or blanching. Pain was relieved for eight hours. He was sent home taking 25 mg. every four hours. During seven months symptoms have been relieved, although not completely, and treatment is continuing.

The second patient had bilateral upper dorsal ganglionectomy one year after onset of symptoms. A year after operation discoloration and pain recurred. When treated, trophic changes of skin or ulcer had not developed. Three intramuscular injections of 75 mg. of Priscol were given at half hour intervals. The first dose effected warming of hands and relief of pain. Second and third injections effected no further change. Oral administration of 25 mg. at six hour intervals in the hospital and at home maintained improvement. After five weeks the patient reported that his hands were better in color and more comfortable but that the drug made him nervous.

A third patient had treatment by Priscol before and after sympathectomy. Symptoms had been present two years. All four extremities were involved but the feet troubled most. Periods of ischemia and pain lasting several days recurred. When first seen an episode had persisted two weeks and produced sharp burning pain and paresthesia of the right foot. This foot was cold and pale but developed rubor when dependent. Dorsal pedis and posterior tibial arteries were fully palpable and oscillometric pulsations in the mid-calf were normal. There was an area of anasthesia about the toe. The left leg and both hands evidence phasic color changes characteristic of Raynaud's disease. On admission the temperature of the right toe was 22.4° C. and of the left, 28.8° C. After hospitalization for two hours without treatment temperatures were respectively 23 and 32. Temperature of skin near the umbilicus varied between 36.3 and 37. Forty milligrams of Priscol were given intramuscularly. Twenty-five minutes later temperature of the right toe was 30.3 and of the left, 36. Fifteen minutes later temperatures were respectively 34.1 and 36. Three hours after Priscol temperatures were right toe, 36.5; left, 36.4, and umbilicus, 37. Twenty-five to 50 mg. were then given intramuscularly every two hours for five days. Toe temperatures were maintained always over 33. Finger temperatures were similarly increased and maintained. Placing of hands or feet in ice water was well tolerated. Treatment was omitted for one day and relapse occurred. Since chronic treatment by Priscol was not being employed when this patient was tested, bilateral lumbar sympathetic ganglionectomies were performed and three months later bilateral upper dorsal

sympathetic ganglionectomies. Increase of temperature of digits similar to that effected by Priscol followed operation. During the next nine months symptoms were relieved but as cold weather returned moderately severe phasic color changes reappeared. Priscol, 50 mg. four times a day, was then given orally at home with definite benefit.

Because of these encouraging results the next three patients encountered were treated by Priscol and have not since required sympathectomy. Their clinical course, tests and treatment were similar and will be described together. All were women. Duration of symptoms was respectively eighteen months, thirty months, and two years. One patient had undergone a right upper dorsal ganglionectomy followed by recurrence. After a year symptoms were again equal in the two hands even though the right remained warmer. In all three patients symptoms were progressive but advanced trophic changes of skin or ulceration had not developed. Fifty mg. of Priscol orally, intravenously, or intramuscularly increased temperature of the digits in each limb of each patient with the exception of one right arm previously sympathectomized. The increase was to within three degrees of abdominal skin temperature in the extremities of two patients and within one degree in the third. The temperature of the sympathectomized limb, however, did not increase. Before Priscol patients would hold their hands in ice water 36 to 89 seconds with sever pain. This was followed by intense rubor and cyanosis and rarely areas of ischemia. Within 15 to 30 minutes after administration of Priscol these patients held their hands in ice water three to five minutes comfortably and stated they could continue indefinitely. Following removal of the hands from ice water after Priscol some redness developed but little, if any, cyanosis and no ischemia. The single oral dose required to effect this protection was 25 mg. in one patient, 50 in another, and 75 mg. in the third. Exposure of two patients in a large refrigerator at temperatures of 40° C. induced phasic color changes, predominantly pallor, before Priscol. After the drug, exposure for fifteen minutes produced no change. Protection against pain and discoloration of the one sympathectomized arm equaled that of the opposite arm.

These three patients have been taking Priscol at home six to nine months. Dose schedules have been varied to determine amount necessary to afford protection from attacks. Each patient has required a minimum of 50 mg. morning, before lunch, mid-afternoon, and evening in cool weather, decreasing dosage on warm days and only occasionally increasing it above this amount. Although slight discoloration of fingers occurs once in a while, particularly before the morning dose, the patients are enthusiastic about results. There has as yet been no evidence of development of toxicity or tolerance and side effects have been considered of minor importance.

2. *Arteriosclerotic obstructive disease of legs.* Fifteen patients varying in age from 47 to 77 had gradually progressive symptoms of incompetent arterial circulation through the legs and feet and clinical critera warranting a diagnosis of arteriosclerosis. Results will be described in three groups: patients tested

and treated by Priscol, tested and treated by sympathectomy, or tested only.

Five patients were tested and then treated by Priscol. Two men, aged 71 and 77, had ulcers about both ankles and feet. They also had angina on exertion. Fifty milligram test doses produced moderate increase of temperature of the feet, and during treatment in the hospital and at home ulcers healed. Since conservative and other medical treatments were also employed, evaluation is difficult but Priscol seemed to assist management.

A third patient, male, age 55, had had one leg amputated. Circulation in the remaning leg was minimum and resting pain had developed. Fifty milligrams of Priscol intramuscularly increased great toe temperature 2 degrees. After an hour another 50 mg. increased it an additional 2 degrees, or to within three degrees of temperature of the skin near the umbilicus. Treatment at home using Priscol and no other medication effected moderate relief of symptoms.

A fourth patient, male, age 55, gave a history of exertional and substernal discomfort and mild episodes of nocturnal dyspnea, during five years. Intermittent claudication developed during the last eleven months. Fifty milligrams intravenously warmed both feet and markedly improved circulation as judged by postural tests. Fifty milligrams were then prescribed for use at home orally four times a day. Although Priscol made this patent nervous, he now states that the feet no longer ache and no longer are fatigued or cramped within two blocks. He can now walk seven or eight blocks before claudication. On two occasions after evening drinking, he has been awakened at night by transient shortness of breath and cough. This patient also states that mental faculties are much clearer when taking the drug.

The fifth patient was a 73-year-old woman, who gave a history suggesting a myocardial infarction seventeen years ago. She since has had recurring attacks of angina. Electrocardiograms were consistent with coronary insufficiency. Slightest exertion produced substernal pain. One year before admission an ulcer of the left big toe developed. It was treated conservatively without healing. During the month before admission pain of the left toe and foot steadily increased. The patient was then hospitalized and treated by intermittent venous occlusion and papaverine hydrochloride for four days with no relief from pain. During the next four days two lumbar sympathetic blocks were employed, each effecting partial relief from pain. In spite of the bad cardiac status, Priscol was tested. Fifty milligrams given intramuscularly and repeated after 45 minutes effected moderate relief of pain but there was no increase of temperature of the involved toe. Two days later lumbar paravertebral block was repeated with a similar result. During the next two weeks 50 mg. of Priscol were given intramuscularly or by mouth every two hours. Intermittent venous occlusion was continued. Pain gradually ceased with the ulcer slowly decreasing in size. The patient was then discharged with instructions to take 25 or 50 mg. at home every three hours when awake. Acute substernal pain, which had been occurring every few weeks before

treatment, recurred once, one month later. Two months after leaving the hospital a fatal myocardial infarction occurred. Comfort in the foot had persisted and at the time of death the ulcer had healed.

Five additional patients with arteriosclerotic vascular obstructive disease were tested using Priscol but not treated by the drug. Three developed increase of temperature of all extremities except the most seriously involved. Because of severe pain, or local gangrene, amputation was advised in each. The fourth had less advanced arterial obstruction. One hundred milligrams of Priscol increased temperature of the left toe 1.7 degrees, and temperature of the right toe, 6.2 degrees. Sympathectomy was advised on the left, to be followed by sympathectomy on the right. The fifth patient, age 41, was tested on two occasions. His right great toe had been amputated a year previously and the wound had healed. When first seen the right little toe was gangrenous. Fifty milligrams of Priscol orally increased temperature of the left great toe until it equaled that at the umbilicus but increased warmth of the right middle toe only to a temperature 3.2 degrees below that of abdominal skin. A right lumbar sympathectomy was then performed, and the remaining toes were amputated. Pain was not relieved and gangrene developed about the amputation site. Twenty-one days after operation pain had increased and the patient was obviously deteriorating. Priscol was again employed as a test. Temperature of the gangrenous foot did not increase after 50 mg. orally. Two and one-half hours later 75 mg. orally again did not increase temperature or relieve pain. An hour later necrotic tissue about the wound was dissected free and removed. Following this the patient screamed with pain even though morphine was given. During the next six hours pre-cordial pain developed and radiated to the left arm. Electrocardiogram the next day revealed abnormal tracings consistent with a posterior infarct. Nine days later the right leg was amputated. Two and six days after amputation electrocardiograms revealed left axis deviation only. Ten days after amputation a cerebral vascular accident occurred with right hemaplegia. Death occurred eight days later. At no time was this patient treated chronically with Priscol.

The remaining five patients of the arteriosclerotic group had tests before or after lumbar sympathetic ganglionectomy. Three were tested before and a week or more after operation. Fifty to 75 mg. of Priscol warmed the most involved foot and toe of two of the patients to a temperature equivalent to that effected by sympathectomy. A week after operation 50 to 75 mg. warmed the other extremities of each patient but did not increase temperature of the sympathectomized limb. The least involved normally innervated limb of the third patient behaved differently. Preoperatively 50 mg. intramuscularly increased temperature of both feet to that at the umbilicus. The day after left lumbar ganglionectomy the temperature of the left foot equaled that at the umbilicus but the right toe temperature was 4 degrees colder than before operation. Temperature of this cool right foot increased only one degree after 100 mg. of Priscol intravenously. Temperature of the sympathectomized leg did not

increase. Two days later the right foot was warmer and responded to 50 mg. of Priscol intravenously by equaling abdominal temperature. Repetition of the same test five days later again similarly increased temperature of the right foot without increasing that of the sympathectomized limb.

Two patients were tested at longer intervals after sympathectomy. One was examined five years after left leg amputation and right lumbar sympathetic ganglionectomy. The temperature of the right foot and toe equaled abdominal skin temperature and did not increase after 50 mg. of Priscol intramuscularly. The other patient was tested eight months after right lumbar ganglionectomy and four months after left lumbar ganglionectomy. Foot and toe temperatures on both sides equaled or slightly exceeded umbilicus temperature. Fifty milligrams of Priscol intramuscularly did not further increase temperature of foot and toe.

3. *Thromboangiitis obliterans (Buerger's disease).* History and clinical observations led to a probable diagnosis of thromboangiitis obliterans in six patients. As nearly as could be determined each had discontinued smoking. The first, a 33-year-old veteran, had involvement of hands and feet during six years and had had episodes of migratory phlebitis. He had been hospitalized elsewhere repeatedly, receiving various treatments including lumbar sympathetic blocks. Sympathectomy had been refused. Priscol, 50 mg. warmed the digits of the extremities less than 2 degrees. Fifty to 75 mg. was then given every three or four hours intramuscularly or orally during three weeks in the hospital. Symptomatic relief was described and an ulcer on the right middle finger healed. A small area of phlebitis developed in the right leg and healed. Treatment was continued orally at home ten days and then discontinued for two weeks. During the holiday another finger developed an ulcer, and the patient stated that his hands were stiffer and more painful. For seven months he has taken 50 mg. of Priscol orally every three hours while awake and has reported satisfaction with treatment.

The next two patients were likewise treated in the hospital before home treatment by Priscol was instituted. One, age 46, had involvement of all four extremities with pain and discoloration of the tip of the right index finger. He was treated in the hospital for nine days, using Priscol and conservative treatment. Relief of pain occurred and the discolored finger improved with demarcation of a small patch of dry gangrene. The other patient, age 58, had had symptoms of thromboangiitis obliterans for fifteen years. His left leg had been amputated and diagnosis had been confirmed by pathological examination. An ulcer of the index finger of the right hand developed and caused pain. An excessively large dose of Priscol, 175 mg., was given intramuscularly. This effected relief of pain and increase in temperature of right thumb and toe. It also produced reduction of blood pressure from 140/95 to 68/60, a chilly sensation and vomiting and diarrhea.

The remaining three patients with thromboangiitis obliterans had sympathectomies before or after Priscol. One gave a history of involvement of

TABLE I.—*Range of Blood Pressure Before .6 Gm. of Sodium Amytal and During Night, Before Priscol and During First Hour Afterward, and After Second Stage of Paravertebral Sympathectomy**

Patient	Age	Sodium Amytal Test		Priscol "Acute Test"		One to two weeks After Sympathectomy
		Before Test	During Night	Before Drug	After Drug	
A. Good reduction after sympathectomy:						
ML	43	250/150→210/130	205/140→154/100	254/170→232/140	189/110→124/70	170/100→100/70
EE	31	200/124 160/110	140/100 130/90	182/122 168/118	148/92 124/74	152/96 104/70
MH	26	290/170 230/150	200/150 160/122	234/162 220/154	210/160 178/132	165/130 140/88
NL	43	240/118 170/98	172/110 130/70	174/92 164/94	186/94 162/86	140/100 100/66
B. Moderate reduction after sympathectomy:						
IS	44	230/140→180/120	178/132→150/100	208/144→190/132	160/102→116/66	164/104→130/70
RR	31	230/130 170/100	180/120 150/100	182/128 160/120	144/96 124/72	170/147 110/88
HF	37	220/170 180/124	190/140 170/120	202/148 182/144	210/132 142/96	180/120 110/82
FP	45	232/130 180/100	180/110 170/96	236/134 212/118	142/112 108/80	198/100 140/70
C. Insignificant reduction after sympathectomy:						
SO	45	210/130→186/106	180/100→150/90	220/136→188/130	110/70 → 86/50	210/132→170/100
MC	44	240/130 200/122	220/140 190/100	230/126 210/188	280/160 240/124	240/130 180/90

* All readings obtained with patient resting in supine position.
Interpretation is difficult but it would appear that reduction after Priscol agrees with that after sympathectomy in patients ML and RR, amytal in FP and SO, both in EE, IS, and MC and neither in MH, NL, and HF.

toes and fingers, beginning ten years ago at the age of 25. Five years before receiving Priscol a bilateral lumbar sympathectomy had been performed and two years ago a bilateral upper dorsal sympathectomy. During the month before treatment an ulcer had developed on the tip of the left middle finger and the entire distal phalanx had discolored. Eight days of treatment using 50 mg. every four hours produced moderate relief from pain. Amputation of the distal phalanx was then performed and the wound healed. Since discharge from the hospital this patient has taken four to six, 50 mg. doses of Priscol each day for five months with the exception of occasional intervals of a week or two without drug for control observation. He states that while taking Priscol the hands and feet feel better, with less stiffness and no pain. His hands and feet feel colder and stiffer and are "tired and more easily fatigued" during periods without treatment. Another patient, age 42, was tested two years and seven months after left lumbar sympathetic ganglionectomy and just preceding right ganglionectomy. One hundred milligrams of Priscol intramuscularly effected moderate increase of temperature of the toes of the non-sympathectomized limb but did not increase temperature of the sympathectomized leg. Increase of temperature of the right toes after the right lumbar sympathectomy was moderate, equaling that effected by Priscol. The last patient, age 32, received 200 mg. intravenously with little increase of temperature of the involved foot. There was also little increase of temperature after sympathectomy.

4. *Popliteal aneurysm.* Three patients with popliteal aneurysm were tested. One had a left popliteal aneurysm at the age of 19. It had been noticed as a small lump for three years and had ruptured six days before admission, producing pain and swelling. Left lumbar sympathectomy and ligation and excision of the defective area of the popliteal artery were performed. The day after operation 50 mg. of Priscol were given intramuscularly. This effected increase of temperature of the right foot and toe, equaling the temperature of the sympathectomized side but did not increase temperature of this operated side. Fourteen days later 50 mg. were given twice intramuscularly, an hour apart, again with warming of the right foot to equal the temperature of the skin near the umbilicus and without increase of temperature of the left leg. The remaining two patients, aged 70 and 77, had popliteal aneurysms associated with thrombosis. Each was treated by Priscol with little effect and both developed gangrene and had amputation.

5. *Causalgia-type of pain and circulatory disorder.* Seven patients with limb pain have been grouped together under the heading *causalgia,* using the term as it is conventionally broadly defined. Each has been treated by Priscol. No patient had peripheral nerve injury with neuroma and pain required for a diagnosis of causalgia according to the limited definition of the term.

The first patient had burning of both feet associated with increased warmth and blood flow, persisting seven months. Pain began after fracture of several foot bones during a fall. Tenderness and pain prevented walking. Sympathetic

blocks were compared with intramuscular injection of 100 mg. of Priscol. Subjective relief of pain was described as lasting 15 to 20 minutes after both procedures. Similar relief was also described after placebo tablets or injections of saline into the lumbar muscles. Treatment since has been psychiatric.

The second patient, five weeks before testing, had had a right great toenail removed for "ingrowing toenail" and had subsequently developed intense pain in the right foot, with increased warmth, dependent rubor, and evidence of increased blood flow. Fifty milligrams of Priscol intramuscularly partially relieved pain and another 50 mg. an hour later completely relieved pain for seven hours. The test was repeated two days later, again with relief, this time persisting six weeks. She returned two weeks after recurrence. Circulation at this time was essentially normal as judged by postural tests. Priscol taken at home for two weeks again relieved pain.

A third patient developed pain in the left great toe after wearing a tight shoe three months before treatment. All arteries were fully palpable but there was dependent rubor of the left foot. Two intramuscular injections of 65 mg. of Priscol increased the temperature of both feet and relieved pain. Priscol was continued at home for one month. All symptoms were relieved, and when the patient returned after a two-week holiday, there had been no recurrence. Postural tests of circulation were normal.

The three remaining patients in this group had upper arm pain associated with some injury of the brachial plexus or the cervical nerve roots. One had an avulsion injury followed by paralysis of the left arm one year before treatment. Motor function had partially returned. When first examined the arm and hand were cold. Atrophy and persistent pain had developed. Upper dorsal sympathetic blocks relieved pain temporarily and a sympathectomy was performed. Warmth and motor functon of the hand increased and muscular development improved but pain recurred within two months. One year after sympathectomy he was hospitalized one week and treated by progressively increasing doses of Priscol. The maximum was 75 mg. every two hours. Pain was relieved but recurred within three weeks. Three months later he was sent Priscol for use at home and took 50 mg. every four hours. Again he reported relief but during continued treatment pain returned. He finally stated that the medicine did not help and discontinued treatment.

A second patient injured his right shoulder two months before admission and gradually developed pain in the right middle and index fingers with ulceration of the index finger. A sympathetic block partially relieved pain for thirty minutes. Fifty milligrams of Priscol orally also temporarily relieved pain. Increase of finger temperature equaled that produced by the block.

The third patient complained of pain in the ring finger and palm of the right hand. This had been present for seven weeks and began after the patient had awakened one night with intense pain between the shoulders. A diagnosis of rupture of the cervical disc between C-7 and T-1 was established and the neurosurgeons removed the protruding portion of the disc. Pain recurred

three weeks later. Three upper dorsal lumbar sympathetic blocks each relieved this pain. One hundred ten milligrams of Priscol intramuscularly and 100 mg. orally similarly relieved pain for an hour and a half. Sympathectomy was subsequently performed but pain again recurred.

The last patient in this group had both legs amputated because of arteriosclerotic vascular obstructive disease with gangrene and intense pain. Pain had persisted one year following the last amputation. Twenty-five milligrams of Priscol were given orally every two hours for two days. This did not relieve pain but did produce nausea and apprehension.

6. *Miscellaneous Vascular and Pain Problems.*

A. Venous Thrombosis or Phlebitis. Three patients with intravascular clotting in deep veins of the leg were tested but not treated by Priscol. Two had had pulmonary emboli, and one had recurring phlebitis with edema. In each patient Priscol warmed the involved leg and foot and relieved discomfort.

A fourth patient had had recurring episodes of left lower leg superficial thrombophlebitis. After removing the saphenous veins and tributaries by stripping and evulsion, episodes of lower leg cellulitis occurred on both sides and edema developed. After the last episode 50 mg. of Priscol intramuscularly brought toe temperatures up to temperature at the umbilicus. A left lumbar sympathectomy was then performed and subcutaneous tissue and veins of the areas of recurrence in both lower legs were radically excised. Two days after operation and again eight days later Priscol brought the temperature of the right foot up to that of the left and equal to that at the umbilicus.

B. Ischemia. Three patients with acute obstruction of blood flow to a limb were tested and treated with Priscol. The first, a 24-year-old athlete, fractured the right tibia. After reduction the right leg and foot were placed in a cast. Two days later pallor of the toes was observed and it was found that motor function and sensation were diminished. The cast was removed. Two hours later the foot remained colorless and neither dorsal pedis or posterior tibial arteries could be palpated. Fifty milligrams of Priscol intravenously effected restoration of a pink color and return of warmth within five minutes. Fifty milligrams were then given intramuscularly every four hours. Twenty-four hours later the dorsal pedis and posterior tibial arteries were fully palpable.

A second patient developed a colorless lower leg after fracture and dislocation of the right knee. Emergency surgery was performed elsewhere. The popliteal artery was thickened and contained a thrombus. The thrombus was removed but blood did not flow through the injured artery. Three days later the foot was discolored. Priscol was then tried without improvement. The third patient, a 65-year-old hypertensive patient with coronary disease, developed an embolus presumably located in the right popliteal artery. Fifty mill-

grams of Priscol were given every four hours for three days, and the patient was heparinized. The foot remained viable, but after recovery the patient complained of claudication and fatigue on exercise.

C. PAIN. As a control for relief of pain described in the above reports six patients with pain or other varieties were tested with Priscol. Four had abdominal pain, one from intussusception, one from common duct obstruction, and two from peptic ulcer. Each was given 50 mg. of Priscol intramuscularly or intravenously without relief from pain. The fifth patient had a painful stasis dermatitis of the left leg. Twenty-five milligrams orally produced warming of the legs but no relief of pain. Another patient with arthritis in the hands was tested both by sympathetic block and by 50 mg. of Priscol intravenously without relief of pain.

THE EFFECT OF PRISCOL ON BLOOD PRESSURE OF PATIENTS WITH HYPERTENSION

Thirty-nine hypertensive patients have been treated or tested with Priscol. In general each had advanced essential hypertension or hypertensive cardiovascular renal disease. Only one had definite coronary disease demonstrated by electrocardiogram. Many had hypertensive retinitis and a few papilledema. The oldest patient was 53. Treatment in the hospital consisted of 25 to 75 mg. of Priscol usually by hypodermic administration every two to four hours. Treatment at home employed 25 to 75 mg. orally every three or four hours. Many patients had tests using Priscol. These were performed by injecting 50 mg. intravenously, followed one hour later by another 50 mg. and then with three exceptions completing the test at the third hour by injection of 100 mg. Blood pressure during the hour after the last injection will be described and transient changes omitted. Occasionally sympathectomy was performed after a week or more of treatment or after a Priscol test. All blood pressures reported below were taken with the patient resting in a supine position. Six types of observations will be presented separately.

1. *Hypertension treated by Priscol during a week or more of hospitalization and then by sympathectomy.* (Five patients.) The first patient had tachycardia and fluctuating blood pressure and was suspected of having an adrenal tumor. After receiving Priscol in the hospital for nine days pressure decreased from around 190/110 to around 134/96. Treatment was continued one month at home. Fluctuations of pressure with frequent high readings recurred and tachycardia persisted. A splanchnicectomy of the posterior Smithwick-type was then performed. Both adrenal glands were explored and neither contained a tumor. The complaint of tachycardia persists but blood pressure remains reduced.

The remaining four patients failed to have significant lowering of pressure during 5- to 10-day periods of treatment even though dosage was increased to 75 mg. every two hours. Each was then treated by total thoracic and partial

to total lumbar paravertebral sympathectomy, splanchnicectomy, and caliac ganglionectomy[27].* Blood pressure following operation was reduced toward normal in two and only moderately lowered in two.

2. *Hypertension tested by Priscol and subsequently treated by sympathectomy.* (Eleven patients.) One patient had no significant lowering of pressure after 200 mg. of Priscol and also no reduction during the second week after splanchnicectomy. Ten patients had Priscol tests, standard sodium amytal tests, and then subtotal to total paravertebral sympathectomy. Results are presented in Table I.

3. *Priscol tests in patients with hypertension persisting after sympathectomy.* Tests were performed in six patients with hypertension persisting 8 to 36 months after treatment by sympathectomy. One had had a splanchnic ectomy. Blood pressure which ranged around 176/114 did not change after 200 mg. Another after splanchnicectomy had a pressure around 230/120. It reduced to 122/68 after 200 mg. of Priscol. The remaining four patients had subtotal to total paravertebral sympathectomies. In three Priscol did not produce significant reduction of pressure. In the fourth the test lowered the reading from around 204/122 to 140/94. This patient was then treated at home and had moderate lowering of pressure.

4. *Hospital treatment of patients with hypertension persisting after sympathectomy.* Four additional patients with hypertension persisting 6 to 26 months after sympathectomy were treated five days or longer in the hospital without using the Priscol test. Three had thoracolumbar splanchnicectomy. Treatment did not produce significant change of blood pressure. The fourth patient had paravertebral sympathectomy. She was treated in the hospital with slight reduction and subsequently at home for two months without significant reduction of pressure.

5. *Hypertension tested and treated by Priscol.* Six patients had 200 mg. tests and then treatment by Priscol. The tests effected reduction of pressure to normal in three and little, if any, reduction in three. During treatment in the hospital for a week or more, a moderate and probably insignificant reduction of pressure occurred. Each was then sent home instructed to take the drug three weeks, discontinue it two weeks, and then, if desired, resume treatment. One patient discontinued treatment after three weeks, stating she felt better and no longer needed it. Of five that resumed treatment for a second three week period only two definitely report relief from headaches or other symptoms. All five continue with hypertension at levels slightly if at all lower than before treatment or than during the two-week holiday.

Three additional patients were tested and then discharged without Priscol but with conventional treatment. In one after the second 50 mg. of the test had reduced blood pressure from 220/140 to around 156/102 weakness

* For convenience this operation will be referred to below as subtotal to total paravertebral sympathectomy. It includes in its denervation sympathetic nerves to the heart and to the adrenal glands.

of the right leg and paralysis of the right arm developed. This subsided after two hours as blood pressure again rose. There was no residual difficulty. The remaining two refused treatment, one did not have lowering of blood pressure with the test but the other had reduction of pressure to normal.

6. *Hypertension treated by Priscol without test or sympathectomy.* Four patients received progressively increasing doses of Priscol during a week in the hospital. In three significant lowering of the blood pressure did not occur. The fourth had moderate reduction but Priscol subsequently taken orally at home failed to maintain lowering.

MISCELLANEOUS OBSERVATIONS AND TESTS OF EFFECTS OF PRISCOL ON CIRCULATION

The first two sections of this paper have described clinical aspects of use of Priscol omitting reference to special observations. Effects of Priscol upon circulation determined by observations made during tests or treatment will be presented below. Material will be grouped under method of observation rather than disease.

1. *Oscillometric studies.* Oscillometric readings obtained at mid-calf level in five patients with severe arterial obstructive vascular disease varied from four-tenths of a point to 3 points. After effective doses of Priscol, readings were unchanged. Similarly, oscillometric readings in three other patients previously treated by lumbar sympathectomy had not been changed by sympathectomy and were not changed after Priscol. Oscillometric readings in six patients with more normal circulation increased a half point or more after the drug.

2. *Peripheral skin temperature gradient.* Skin temperatures were obtained at 10 and 15 minute intervals an hour or more before Priscol and three to twenty-four hours afterward using a McKesson Dermalor. Room temperature could not be kept cool or constant. The gradient of each leg was determined by comparing temperatures just below the umbilicus, over the trochanter, on the medial aspect of the knee, below the medial malleolus, over the dorsum of the foot, and on the tip of the great toe. The gradient of each arm was determined by comparing temperatures over the sternum, over the deltoid, on the lateral aspect of the elbow, over the thenar muscles, and at the tip of the middle finger. Usually, the toes were four to ten degrees centigrade cooler than skin by the umbilicus and the finger zero to four degrees cooler than skin over the sternum.

In general after Priscol this gradient decreased, usually within five minutes after intravenous administration, within twenty minutes after intramuscular injection, and within forty-five minutes after oral administration.

Before Priscol the gradient of five hypertensive and twelve peripheral vascular disease patients was within normal range, and of six peripheral vascular disease patients exaggerated. After 50 mg. or more of Priscol skin temperature gradients of the hypertensive patients were abolished, toe tem-

perature equaling temperature by the umbilicus. The gradient of eight of the peripheral vascular disease patients was similarly abolished after Priscol. Another eight had decrease of gradient. Gradient was unchanged after Priscol in only two patients.

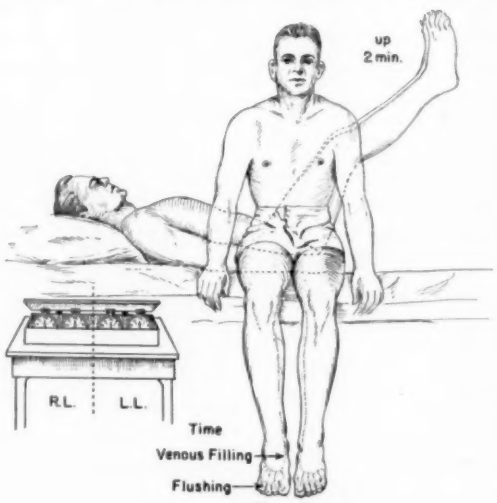
Six patients were tested after lumbar sympathectomy. Gradient of the sympathectomized limb had been abolished by the sympathectomy. After Priscol, gradient of the opposite limb without sympathectomy was similarly abolished but temperature of the sympathectomized limb remaind unchanged or increased slightly, less than 1°. Similar observations and similar results were obtained by testing upper extremities of three patients with upper dorsal sympathetic ganglionectomy. Five of the above nine patients also had Priscol tests before sympathectomy. In each the loss of gradient by test equaled that produced by sympathectomy.

Patients who were treated continuously, receiving 50 or 75 mg. of Priscol every few hours, had moderate increase of foot and toe temperature but did not maintain the marked warming of the foot or abolition of skin temperature gradient accomplished by initial single test doses.

POSTURE TEST-OBSTRUCTIVE VASCULAR DISEASE.

MILD ARTERIOSCLEROTIC

Right		Left	
Flushing	Venous Filling	Flushing	Venous Filling
4.0	25.5	5.8	30.0
6.0	21.0	6.0	30.0
5.5	24.0	5.5	25.0
4.0	28.2	5.5	24.5
5.7	24.6	5.5	30.0
4.6	25.0	4.4	26.3
Priscol 50 mg. i.v.			
3.6	16.9	3.1	14.3
3.4	18.9	2.3	13.3
0	23.7	0	13.3
0	15.1	0	12.6
0	15.3	0	12.0
0	15.8	0	11.4
0	14.3	0	9.3
0	10.0	0	9.5



SEVERE ARTERIOSCLEROTIC

Right		Left	
Flushing	Venous Filling	Flushing	Venous Filling
4.7	7.6	72.2	26.0
3.8	6.0	69.1	25.9
3.3	8.6	84.2	27.2
3.9	10.4	97.0	37.2
Priscol 50 mg. i.v.			
4.9	15.7	126.6	36.3
3.3	10.4	124.7	55.7
3.1	10.0	96.0	33.8
3.7	7.9	85.0	20.3
2.7	7.7	95.2	24.6
2.9	6.5	96.1	21.0
2.7	5.5	86.2	17.9
2.1	5.2	91.0	21.5

FIG. 1.

3. *Dependent flushing and venous fillng.* These observations were made after a patient had been lying in bed two minutes with feet elevated at a 45-degree angle. (Figue 1). The patient then sat up and dropped his feet over the side of the bed. Time of appearance of pink color, "flushing" of toes, and time of onset of filling of veins of the foot were observed. Approximate observation and timing in 14 patients without serious arterial obstruction indicated that after Priscol flushing and filling of superficial veins occurred more promptly. Color photographs taken in five patients after 15- and 30-second intervals of dependency before and after Priscol confirmed this observation. Accurate timing in 12 patients using four stop-watches also

confirmed the observaton. The record presented at the left of Figure 1 and the change after Priscol is typical of most studies. The record at the right of Figure 1 illustrates a typical response to Priscol of the right leg. Flushing time in the left leg is, however, further delayed after the drug. This patient had been admitted for amputation of the left leg. Sympathectomy was probably contraindicated.

4. *Cold pressor test.* A "cold pressor test" was performed before and after Priscol in 23 patients with hypertension. Blood pressure was first observed at minute intervals six times or until constant. One hand was then placed in ice water for one minute obtaining pressure readings at 30 seconds and at one minute. Subsequently six additional readings were obtained at minute intervals. Twenty hypertensive patients without sympathectomy were tested. A definite increase of pressure occurred in eighteen. After two 50 mg. doses of Priscol an hour apart, the cold pressor test was repeated in nine patients. Pressor response was abolished in five and reduced in four. After a third injection of 100 mg. an hour later, 17 patients were tested. The pressor response was abolished in 12, reversed in 3, and reduced in 2. Three patients previously treated by subtotal paravertebral sympathectomy were also tested. A pressor response occurred in each before the drug. After 200 mg. it was reduced in 2 and abolished in one.

5. *Breath holding.* Breath holding tests were performed in the same group of patients described under the cold pressor test. Blood pressure was recorded six times at minute intervals. Patients then held their breath in expiration as long as possible. Time of breath holding varied from fifteen to thirty-five seconds, average twenty-five. At the moment the patient again took a breath blood pressure readings were obtained. Subsequently pressures were recorded at minute intervals for six minutes. Of twenty hypertensive non-sympathectomized patients tested, eighteen had a definite increase of pressure before Priscol. Ten were tested after two 50 mg. intravenous injections of Priscol an hour apart. The pressor response was not changed in one, reduced in five, and abolished in four. After a third intravenous injection of 100 mg., seventeen patients were tested. The pressor response was reduced in three, abolished in thirteen, and reversed in one. Three patients previously treated by paravertebral sympathectomy were also tested. Two had a positive response which was reduced but not abolished after 200 mg.

6. *Blood pressure—supine position.* The effect of intravenous administration of varying doses of Priscol upon blood pressure of patients with hypertension and of patients with peripheral vascular disease but with relatively normal pressure was determined. Twenty-two patients with hypertension were tested. During one hour after injection of 50 mg., fifteen had no change of pressure, three moderate reduction, and four moderate increase. A second injection of 50 mg. was then given. During one hour afterward fourteen had no change, seven moderate reduction and one reduction to normal values. Seventeen patients received a third injection of 100 mg. or

altogether 200 mg. of Priscol. Blood pressure remained unchanged in five, moderately reduced in four, and reduced to normal in seven. One patient had temporary reduction below normal to shock levels but recovery was spontaneous. Temporary pressor responses not exceeding 20 mm. systolic were observed in four of the above 22 patients during the first five minutes after injection.

Three patients with hypertension persisting after paravertebral sympathectomy were similarly tested. After 50 mg., pressure was unchanged in two and increased in one. After 100 mg., it was slightly reduced in two and increased in one. After 200 mg., it was reduced in two and reached normal values in one.

Thirteen patients with peripheral vascular disease and essentially normal blood pressure were tested. During one hour after 50 mg. nine had no change, one slight reduction, and three moderate increase. Nine were tested after 100 mg. Six had no change, one moderate reduction, and two moderate increase. Three were tested after 150 mg. Pressure remained unchanged in six and was moderately reduced in three. Temporary pressor responses not exceeding 18 mm. systolic were observed in three of these thirteen patients during the first five minutes after injection.

7. *Blood pressure—standing.* Blood pressures were obtained in sixteen patients with hypertension an hour or more after the third injection, or a total of 200 mg. of Priscol. After standing several seconds to a minute, twelve had reduction of pressure to the point of syncope. Four had marked postural hypotension although not to syncope. Blood pressures while standing were also obtained twice daily in ten hypertensive patients during a week or more of treatment in the hospital. Each persisted with moderate postural hypotension but not to syncope. A moderate postural hypotension also usually persisted in patients treated at home a month or more. Patients with normal blood pressure and with peripheral vascular disease also developed marked postural hypotension after injection of 100 to 200 mg.

8. *Pulse rate.* Pulse rates were determined frequently during tests of twenty of the group of patients with hypertension. Transient increase of rate during the first two or three minutes after each injection occurred in sixteen patients. Persisting rate during the hour following each injection varied from patient to patient. In ten after 50 mg. there was no change, in eight, an increase up to ten beats per minute, and in two an increase of ten to twenty. After the second injection, altogether a total of 100 mg., pulse rate remained unchange in five, increased up to ten per minute in six, increased ten to twenty in six, and increased by twenty to thirty in three. In 19 patients after a third injection or altogether 200 mg., pulse rate remained unchanged in five, increased up to ten per minute in nine, increased ten to 20 in three, and increased 20 to 30 in two.

Three patients were tested after heart and adrenal denervation by paravertebral sympathectomy. Pulse rate did not change after 50 to 100 mg. After

200 mg. the rate of two patients remained unchanged and of one increased four beats per minute.

Patients receiving continuous treatment ordinarily have a normal pulse rate. A few describe occasional sensation of rapid beating of the heart lasting a few minutes.

9. *Pupil.* Temporary dilatation of the pupil was observed after injection of 50 mg. in four of 20 patients with hypertension, and after 100 mg. in two. Dilatation did not occur in three patients with paravertebral sympathectomy which includes sympathetic denervation of the head. In all patients after all doses, pupils appeared normal, dilated in darkness, and constricted in light. Patients read easily throughout test periods even after a total of 200 mg. of Priscol.

10. *Respiration.* After intravenous injection of small or large doses of Priscol a few patients described momentary "shortness of breath" and took several deep breaths. Persisting respiratory rate of twenty-four patients accurately timed did not change in nineteen and was increased from two to four per minute in five.

11. *Response to adrenalin.* Response to adrenalin was tested in one patient with hypertension. Control blood pressure was around 206/108. After 10 drops intravenously of a mixture of 200 cc. of saline and 1 cc. to 1000 adrenalin pressure increased to 234/92. After twenty drops it increased to 248/100 and again after 8 drops to 240/100. This patient was then treated for three days by hypodermic injection of 50 mg. of Priscol every 4 hours. During the second day of treatment adrenalin was again administered using a similar and freshly prepared solution. Sixty drops were injected within two minutes. Blood pressure decreased from around 218/116 to 200/78. Twelve hours after Priscol was discontinued 10 to 23 drops of a similar solution again produced marked pressor responses.*

12. *Response to anesthesia.* A 58-year-old-man patient suspected of having a pheochromocytoma or a paraganglioma was given three successive intramuscular injections of 50 mg. of Priscol during two hours preceding exploratory laparotomy. Ethylene, ether and curare were used for anesthesia. During two and one half hours under anesthesia and during the administration of 750 cc. of whole blood, 500 cc. of plasma, and 800 cc. of 5% dextrose in saline, blood pressure varied from around 110/160 to 170/110. There was no evidence of reflex change of pressure from manipulation or traction of abdominal viscera or of increased pressure when adrenal glands were inspected and palpated. No tumor was found.

13. *Temperature gradient of pedicle skin tubes.* Three patients with skin tubes in various states of preparation or transplant were given Priscol intramuscularly. One tube had been raised from the lower leg but had both ends attached. After 69 mg. of Priscol temperature in the center of this graft rose 1.6° C. A second tube had been raised from the chest to the ear, but was

* A preliminary report (25) has described additional experiments in man demonstrating adrenolytic action of Priscol. Results will be amplified in another paper.

still attached to its site of origin. Temperature in the center of the graft rose 1.4° C. after 65 mg. of Priscol. The third tube had been transplanted to the right hand and then moved from the site of origin to a defect of the lower lip, thus eliminating its original nerve supply. Temperature rose 1.9° C. after 53 mg. of Priscol. Color photographs of each tube clearly demonstrated increased redness.

14. *Cardiac output.* Observations have been made on three patients by J. B. Hickam, who will report details and further studies. All readings were taken in the horizontal position. Two patients had mild hypertension and one thromboangiitis obliterans involving four extremities. No patient had clinical evidence of impairment of cardiac function. Cardiac outputs were determined by the Fick principle using the technic of cardiac catheterization. Patients were tested under basal conditions and again 30 minutes after 50 mg. of Priscol intravenously. In two, cardiac output did not change. In the third, an apprehensive patient with a high control value, the output decreased to a normal level after Priscol. One patient received a second injection of 150 mg. of Priscol one-half hour after the first. His output one-half hour later was unchanged. Response to five minutes of leg exercises was also tested before and one-half hour after 50 mg. of Priscol. For equal amounts of exercise the cardiac outputs were identical.

15. *Urinalyses and blood counts.* Urinalyses were obtained in seventeen patients before, during, and at the end of continuous treatment with Priscol for a week or more in the hospital. The longest period of treatment was nineteen days. Changes or abnormalities did not occur. Hemoglobin, red and white blood counts were similarly obtained in fifteen patients, in four instances supplemented by differential counts. With one possible exception changes or abnormalities did not occur. In one patient the white blood count dropped from 9,000 before Priscol to 3,110 after ten days on the drug. Two days later while receiving the drug the count was 5,550 and one month after discontinuing treatment it was 9,000. The only other drug administered with the Priscol in this patient was sodium pentobarbital, .1 Gm. the two evenings before the low count. Eleven patients checked while receiving Priscol at home for periods up to seven months have had no significant change in urinalysis or red and white blood count.

DISCUSSION

Favorable reports of use of Priscol for a variety of peripheral vascular diseases have appeared in European and South American literature. Our clinical experiences with this drug during periods of treatment not exceeding nine months have confirmed these reports. Single doses of 25 to 75 mg. evidently with few exceptions produce changes in circulation of limbs equivalent to those produced by sympathetic block or sympathectomy. Continuing treatment by this dose schedule maintains benefit but does not entirely equal the effect of sympathectomy. Results in treatment of Raynaud's disease have been encouraging and unless evidence of toxicity or tolerance develops, sympathectomy is no longer recommended by us. Results in treatment of vasospastic

ischemic extremity problems and causalgia states have been encouraging. Results in treatment of thromboangiitis obliterans and arteriosclerotic peripheral vascular disease are less easily evaluated. At present treatment is limited to patients refusing sympathectomy or those with complications contraindicating sympathectomy. Treatment has been and is currently being offered to patients with peripheral vascular disease complicated by coronary heart disease. Nevertheless, theoretically at least, harm may develop from drug action on the heart. Of 9 patients with known progressive generalized arteriosclerotic vascular disease and coronary involvement, tested or treated by Priscol, two developed myocardial infarction. Our clinical impression that this would have occurred had Priscol not been used cannot be established without further experience. Patients without known coronary heart disease have not as yet developed cardiac complications. Doses of Priscol over 75 mg. should, however, be avoided in patients with known obstructive disease of coronary or other arteries since reduction of blood pressure might occur with adverse effects.

A test intravenous injection of 50 or 75 mg. of Priscol may aid prediction of immediate results of sympathectomy in patients with peripheral vascular disease.

Attempted treatment of hypertension by Priscol in dose ranges up to 75 mg. every two hours has yielded encouraging results in only a few instances. Similarly, use of a Priscol test for hypertension or of Priscol treatment a week or more in the hospital has not aided prediction of results of sympathectomy.

Oscillometric readings at calf level in patients with marked organic arterial disease were not changed by Priscol. It is our experience that low readings are seldom altered during the first week after surgical sympathectomy. Increase of readings occurred after Priscol in patients with less arterial obstruction. Skin temperature gradient of arms and legs was usually decreased or abolished after Priscol test doses. Warming of hands and feet was less marked during continuous treatment. Evidence of more rapid dependent flushing and venous filling of toes and feet after Priscol adds to evidence that blood flow through extremities may be increased, arterial supply permitting.

It is of interest that goose flesh frequently would be observed over the body after Priscol; also, it appeared on the skin of sympathectomized limbs. This would indicate a peripheral effect. Sweating, frequently produced by doses of Priscol of more than 75 mg., never appeared in sympathectomized areas. This would indicate dependency on innervation.

Doses between 100 and 200 mg. blocked pressor responses to placing a hand in ice water or to breath holding. Cold pressor block is conventionally believed an indication of complete sympatholysis. We have, however, observed definite pressor responses in patients evidently totally sympathectomized. Block of pressor response to breath holding is possibly an indication of sympatholysis. Postural hypotension develops after sympathectomy for hypertension. Postural hypotension observed after large doses of Priscol equals or exceeds that after subtotal to total paravertebral sympathectomy.

Ordinarily, injection of Priscol did not dilate pupils. Dilatation did occur in a few patients but never occurred if the pupil had been sympathectomized. It would seem that dilatation when observed was caused by apprehension or an alarm-type of reaction. Rate of respiration was not significantly altered even by large doses, and there is no indication except for block of pressor responses of the breath holding tests that respiratory mechanism is effected.

Occasional observations in the absence of sympathetic innervation have indicated that Priscol may have a peripheral and perhaps histamine-like effect. Patients who have had sympathectomy, for such diseases as Raynaud's, state that the drug makes their hands feel warmer and more comfortable. One completely transplanted skin tube increased in temperature after Priscol. It is possible that a peripheral effect might be related to block of action of circulating adrenalin. Presumably, all of the hypertensive patients treated by paravertebral sympathectomy had denervation of both adrenal and cardiac areas. Nevertheless, blood pressure lowering was occasionally produced by Priscol. It could also be assumed that block of circulating sympathin might permit dilatation of denervated vessels. From experimental evidence in animals, however, it would appear that Priscol may have histamine-like action in addition to its potent andrenolytic and sympatholytic properties.

CONCLUSIONS

1. Priscol in doses of 25 to 75 mg. is a useful adjunct to treatment of many peripheral vascular diseases or circulatory disorders and in this dose range usually is tolerated with few side effects.
2. Priscol in test doses of 100 to 200 mg. has lowered blood pressure of many patients with hypertension but sustained treatment by smaller doses has aided only a few.
3. Priscol has adrenolytic and sympatholytic properties in patients and may also have some histamine-like effect.

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DISCUSSION.—DR. GEORGE D. LILLY, Miami, Florida: I should like to compliment Doctor Yeager upon his presentation of this most timely subject. I agree with him that we must stress the importance of thorough sympathectomy.

Due to the fact that I live in a semi-tropical climate, I probably see more failures than most people, because so many of these patients come south in the winter to avoid some of the misery which cold weather produces in persons suffering with peripheral vascular disease. It has been most discouraging to me to examine many people who have had little or no improvement following sympathectomy, only to find that they are sweating profusely down to the knee, or lower. I feel that inadequate sympathectomies are giving the procedure a bad name. Too many of these procedures have been turned over to house officers with inadequate experience, and too many of them have been attempted by persons who have not familiarized themselves with the bizarre anatomy of

the lumbar sympathetic nervous system. Our own hospital pathologist, after examining some alleged lumbar sympathectic trunks, has had to make diagnoses of lymphatic chains, fascia, fat and connective tissue, and genitofemoral nerve.

I feel that a great many so-called regenerations are really not regenerations; they most probably represent cases who had an inadequate sympathectomy in the first place. I have had the misfortune of trying to operate on some of these people again. As most of you know, this is a most difficult undertaking, when one attempts to go back through the same retroperitoneal incision. I have found, however, that in many cases an adequate sympathectomy can be accomplished by resecting the distal half of the twelfth rib and approaching the lumbar sympathetics from the sub-diaphragmatic region, as one does in a Smithwick type of sympathectomy. In this way, the upper lumbar sympathetic trunk can be identified, and the trunk then followed down into the scar tissue of the previous operation.

BOOK REVIEW

Text book of General Surgery, 5th Edition 1948. Warren H. Cole, M.D., and Robert Elman, M.D., New York, D Appleton-Century Co., Inc.

This excellent text book of general surgery has been revised and brought as nearly up to date as is possible in a rapidly progressing surgical world. It begins with a chapter on the history and physical examination of the surgical patient, then proceeds to develop chapters on the basic surgical principles of tissue repair, asepsis and antisepsis, infection, chemotherapy, wound healing, infusions, anesthesia and convalescence. Other chapters describe the principles of the management of amputations, thermal injuries, diabetes in surgical patients and the recognition and management of shock. The authors have emphasized the pathogenesis and important physiologic, biochemical, and bacteriologic processes that are associated with these conditions.

The chapter on neoplasms and cysts classifies and describes surgical pathology, general principles of management and prognosis of surgical neoplastic pathology and photomicrographs of common neoplasms.

The chapters dealing with surgical conditions in specific anatomical regions or systems relate principles of diagnosis, pathogenesis, surgical pathology, and, in appropriate places, the physiological, chemical and bacteriological considerations associated with the disease and its surgical treatment. Principles of preoperative and postoperative management and general surgical procedures are described adequately, but the details of technical procedures are quite properly omitted from this single volume text book of general surgery. Appropriate Diagrams and graphs illustrate important principles and there are many well placed illustrations of surgical pathologic conditions.

The final chapter on military surgery demonstrates the organization of general surgical services under wartime conditions and describes the principles of the surgical care of the usual injuries encountered in World War II.

Many excellent surgical authorities have contributed to the material in this text, presented with exceptional clarity from the viewpoint of general surgeons. The style is brief and concise. This is a superb book of general surgery for medical students. It is an excellent modern general surgical reference book for general practitioners, surgeons and teachers of surgery.

CARCINOMA OF THE BREAST*

WM. PERRIN NICOLSON, JR.
AND
EDGAR D. GRADY
ATLANTA, GA.

PESSIMISM continues to dominate the thoughts of the majority of those dealing with carcinoma of the breast. Education of the laity has brought the patient in somewhat earlier. The use of radiation, either by roentgen-ray and/or radium, either pre- and/or postoperatively, has shown some improvement in results in the hands of most workers. The recent use of hormones may add a ray of sunshine to the dark gloomy picture that has existed. In spite of these improvements, the salvage rate has not materially increased. A statistical study is, of necessity, a dry and dull one but it is only by comparing honestly presented figures in many large groups of cases that we can hope to make progress.

This paper will present a study of 905 cases of carcinoma of the breast seen at the Steiner Cancer Clinic in Atlanta, Georgia, between its inception in 1924 and January 1, 1942. One of us (W.P.N.) reported on the first 261 of these cases, of which 78 were "primarily operable", according to the dicta laid down by the late Burton Lee. In addition to these, this report will include those cases seen since June 1, 1930, and before January 1, 1942, during which time, 644 cases were admitted. A total of 417 were treated surgically. In this latter group, the primarily operable cases have not been segregated. There were 76 cases in which palliative surgical procedures were carried out and 341 in which those procedures were carried out with the hope of obtaining a good result. Consequently, this last series will not show as good figures as the first. One should specify how his figures are obtained. These cases were both negro and white in a low income group, no private cases being included in the series. They were, as a rule, in a more advanced stage than those seen in private practice and the follow up is not as adequate as is possible with private patients. Of the 417 cases, 358 were followed for a period of five years or more. Sometimes these follow ups were obtained through the bureau of vital statistics and in many instances, it could be ascertained that the patients had died but, whether or not they had a recurrence at the time of their death, could not in every case be determined. In calculating the percentages, those cases which have been lost sight of were not included in the figures. The operations were performed by twenty or more surgeons, in many instances the resident surgeons. The type of operation was not the same in each case. This study was begun with no idea of proving or disproving any pet theory but to evaluate our work and see where we stood.

In most instances, these patients received a preoperative cycle of roentgen-ray treatments, followed in approximately two or three weeks by a radical

*Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

mastectomy. In most cases a postoperative cycle of roentgen-ray treatments was given. In selected cases simple mastectomies were performed. This study will analyse the occurrence and results from many angles.

Chart I illustrates the occurrence as to age groups. These varied from two who were less than 25 years of age to one over 80 years of age. It is surprising to note that the results in the third decade were practically the same as those in the fourth, fifth, and sixth. We had previously considered those cases occurring in the early age groups as having much poorer chances

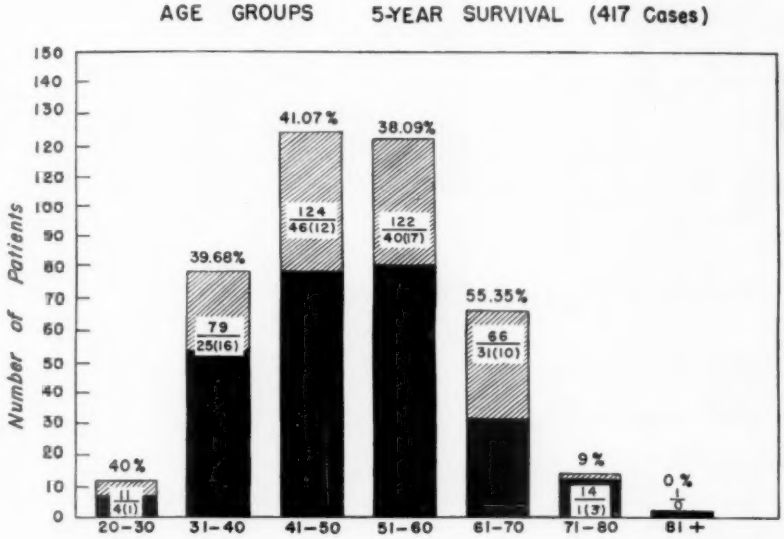

CHART 1.—The percentage figures at the top of each column look forward to the per cent five year survival. The numerators of the fractions in the columns indicate the total number of patients in each group. The denominators indicate the actual number of five year survivors. The figures in parenthesis refer to the patients who were lost in follow-up. They are not included in the calculations of the percentage of five year survivors. The solid black portions of the columns indicate the number of patients died or lost in follow-up in each group. The shaded portions of the columns indicate the number of five year survivors in each group.

than the later ones. The best results were obtained in the seventh decade and there is then a very sharp decline in the last two. Table I illustrates the marital status in 410 cases in which this information was available. There is nothing remarkable in this series except that those persons who had not been married show a 5% better five-year end result than those who had been. We hope that this is not a contraindication to marriage.

Chart II indicates the "chief complaint" occurring in these cases. As would be expected, by far the largest group is that with a lump in the breast. The next group is a painful lump in the breast, whereas, pain is present in only 5% of the cases as the chief complaint. This is in accord with practically all series that have been reported and is encouraging in that it can be used as a means of consoling the large number of frightened women who come in

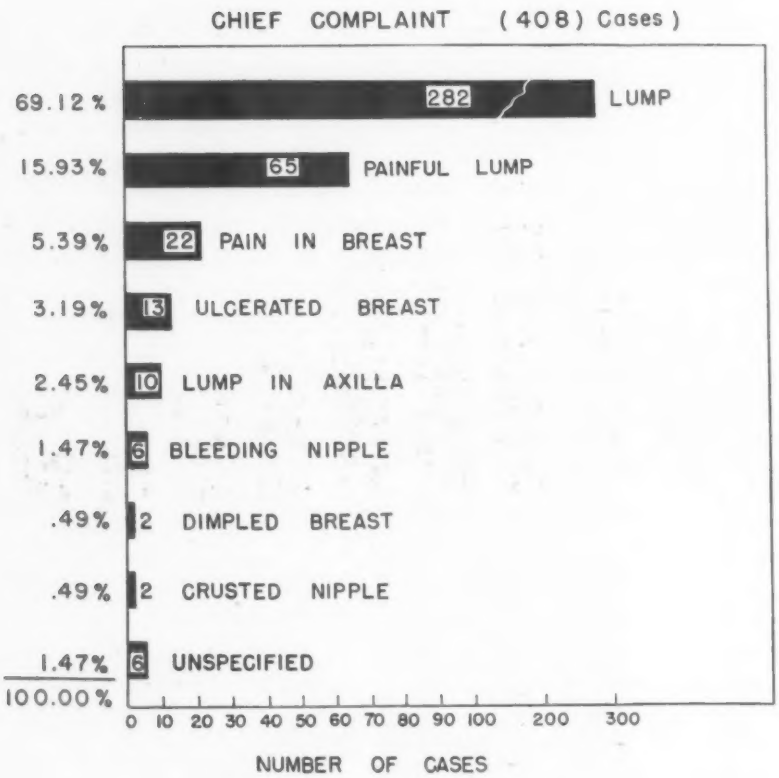

CHART 2.—Chief complaints of cases.

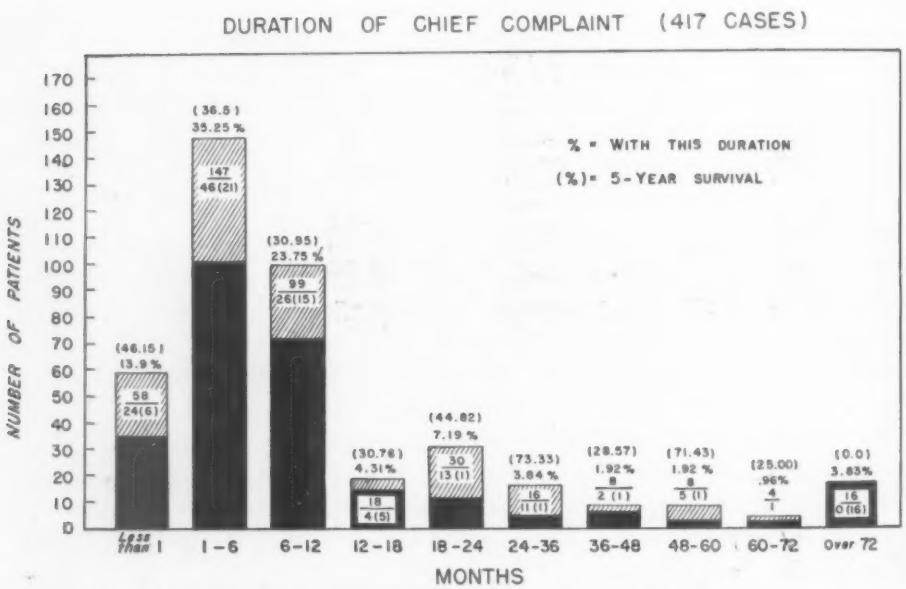

CHART 3.—Fraction with each column same as in figure one.

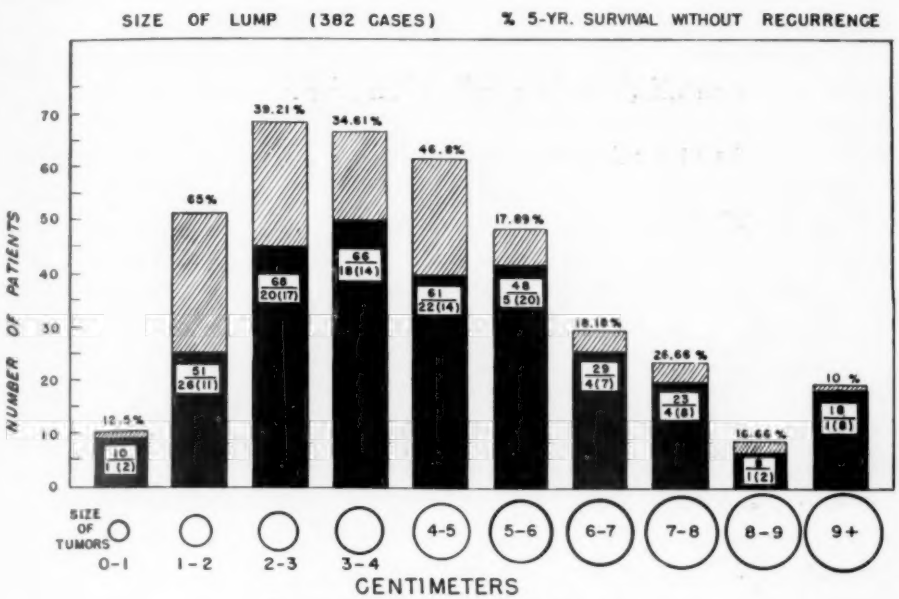

CHART 4.—Size of lumps in breasts.

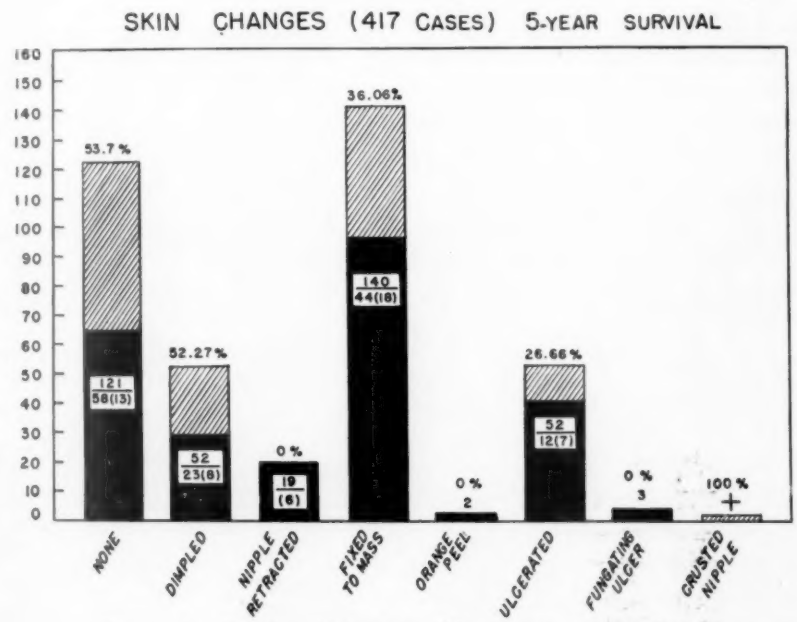

CHART 5.—Results obtained in 390 cases in which changes in skin were noted.

because of pain in their breast. Chart III records graphically, the duration of the chief complaint. It is discouraging to note that in over 25% of the cases, the chief complaint had existed longer than a year, and in less than 15%, was the patient seen in less than one month after the chief complaint

appeared. As would be expected, the results in these groups vary directly with the duration of the chief complaint until a period of 24 months has elapsed and then there's a sharp rise in survival to be accounted for, presumably, by the fact that any growth which has existed over two years, must of necessity, be of a relatively low malignancy.

A history of cancer in the family was not obtained in 76.74% (321 cases); in only 12.23% (51 cases) there was history of cancer other than that

TABLE I.—*Marital Status (410 cases)*

	Married 193	Single 62	Widowed 155
5 Year Survival....	69 (40.82%) (24 not followed)	23 (45.09%) (9 not followed)	52 (40%) (25 not followed)

of the breast, and in 6% (25 cases) there was history of cancer of the breast.

There was no history of injury to the breast in 80% (331 cases), while in 5.5%, there is history of an injury followed by a tumor, and in 5.75%, history of recovery from an injury and later developing a tumor. In 4.31%, a history of a breast abscess occurring earlier was obtained, and in only 1.5% (6 cases) was there a history of an injury followed by an accentuation of the growth of the tumor.

A discharge was noted from the nipple in many cases. It is considered significant, especially if bloody. In 78% (368 cases) there was no history of discharge. In 5.5% (23 cases) there was history of a bloody discharge,

TABLE II.—*Relation to Menopause (360 cases)*

	Premenopausal	Menopausal	Postmenopausal
	134	8	218
Survived without Recurrence 5 Years or More	42 (42%)	3 (50%)	50 (31.44%)
Not followed	(34)	(2)	(59)

TABLE III.

Type of Operation	Radical		Simple		Simple C Removal of Axillary Nodes	
Healing of Wound	Pre-op. X-Ray	No. Pre-op. X-Ray	Pre-op. X-Ray	No Pre-op. X-Ray	Pre-op. X-Ray	No Pre-op. X-Ray
Less than 7 days	3.08	none	5.71	33.33	none	none
8–10 days	4.32	7.7	5.71	none	none	none
11–14 days	11.78	7.7	25.71	22.22	none	none
15–21 days	24.7	26.92	11.42	22.22	28.57	none
22–30 days	17.81	15.4	5.71	22.22	none	none
31–60 days	27.16	23.1	20.00	none	71.43	100%
Over 60 days	14.2	19.23	14.3	none	none	none
Infection:						
Present	17%	11.86	18.18	30	36.36	16.67
Absent	83	88.14	81.82	70	63.64	83.33

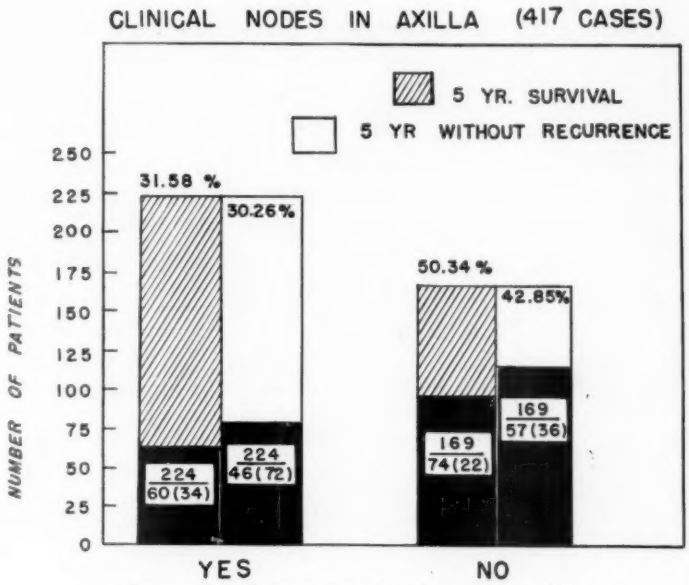

CHART 6.—Occurrence of nodes in the axilla.

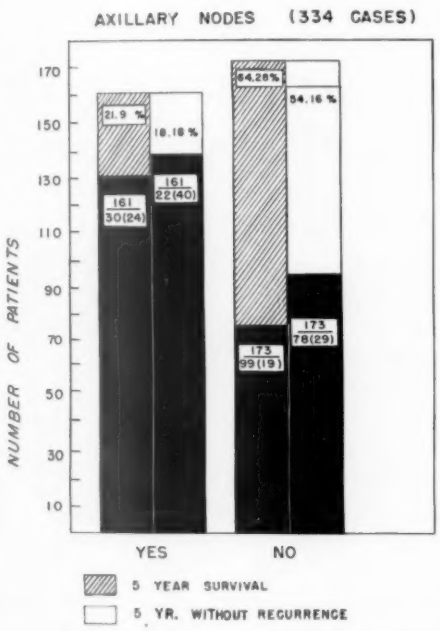

CHART 7.—Occurrence of nodes in the axilla.

in only one-half of 1% was a purulent discharge noted, and in 3% (12 cases) had a serious discharge, and in all of these cases the chief complaint had been something other than a discharge.

In approximately 94% (390 cases) there was a history of having had a lump in the breast. In 19, there was no history of lump in the breast.

The duration of the history of a lump varied greatly. In 11% (46 cases) it had existed for less than one month, in 34% (142 cases) from one to six months; in 22.5% (94 cases) from six to twelve months; and then we note, progressively, 4.5% between twelve and eighteen months; 6.5 between eighteen and twenty-four; 3.5% between twenty-four and thirty-six, etc., until we find that in nearly 25% of the cases, the lump had existed over a year and up to six years. It is alarming to think that in this day of enlightenment and cancer education, a fourth of the patients would have a lump in their breast for over a year and some as long as six years without consulting a doctor. This is certainly discouraging.

The question of whether or not pregnancies have occurred is an important one. In 72% (331 cases) there had been no history of pregnancy. No conclusions should be drawn from these figures unless one also knew the percentage of the same age group in the general population who undergo pregnancies. About 14% had had one pregnancy and a similar number had had two. Only 9% had had three pregnancies, and then the number greatly decreases to 2% having had seven pregnancies and nearly 5% had eight. 72% had had no miscarriages, 10% one miscarriage, 4.8% two miscarriages, 2% had had three. The duration of the lactations varied. Four had lactated for

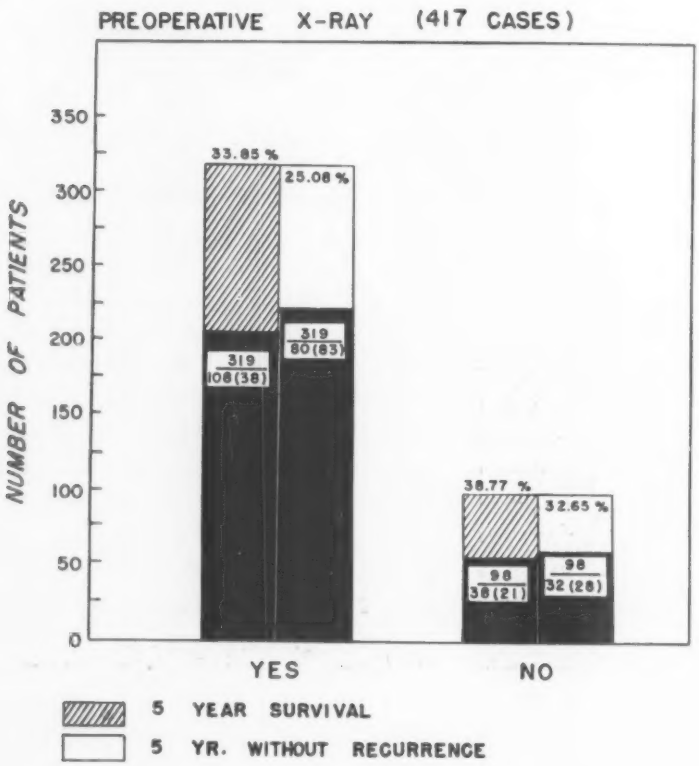

CHART 8.—Results in relation to whether or not pre-operative radiation was given.

less than two months, 27 from two to 12 months, 24 over 12 months, and in 185, the period of lactation was not specified. One of us (W.P.N.) has previously emphasized the importance of lactation as a prophylactic measure in cancer of the breast. Drabble examined the udders of all cows slaughtered at the State Abattoir at Homebush Bay, New South Wales, Australia, from 1926 to 1929 and found not a single instance of carcinoma of the udder, and epitheliomata in only 3 cows. Trout, in a paper before this association quoted this work, as well as that of Bagg at Memorial, in support

of the feeling that stagnation and failure to lactate contributed to the development of mammary carcinomas. The present day interest in the effect of hormones on cancer in general and on cancer of the breast in particular, would emphasize this group of cases. No consideration of hormonal therapy can be included in this report because none had been administered at Steiner Clinic previous to 1942. It is interesting, however, to note any discrepancies in the menstrual history of these patients since this would tend to indicate some effect from hormones. In 50% of the cases, the menstrual history was perfectly normal, and of these, 39% lived five years without recurrences. In 2%, there was history of a painful breast at menstruation and in these cases, only 14% survived five years without recurrences. In 3%, an hyster-

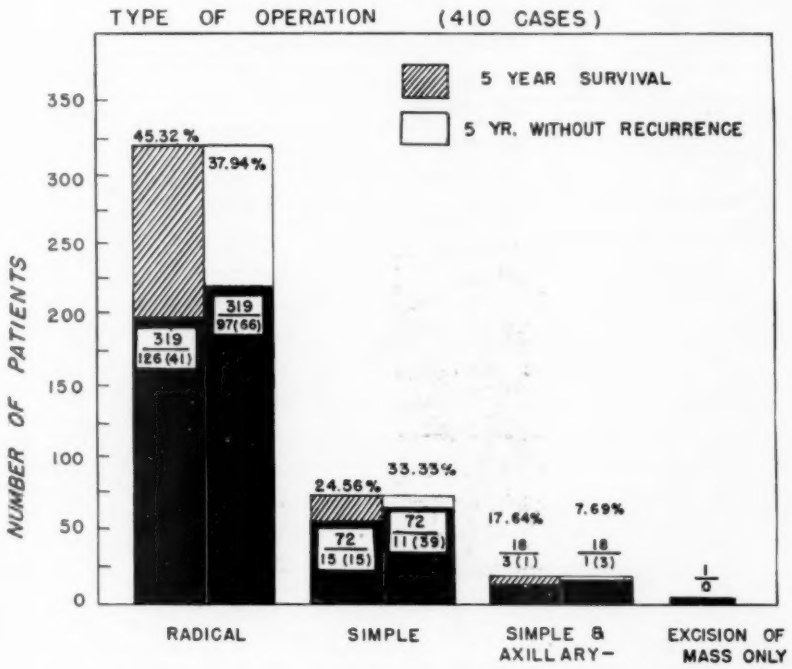

CHART 9.—Types of operations performed with five-year survival rate and the survival without recurrence in each type of operation.

ectomy had been performed, and none of these survived five years without recurrence. Other abnormalities in their menstrual histories were noted in 5.25% and of these, 28% survived without recurrences, and in 40%, the menstrual history was not recorded. Table II records the occurrence in reference to the menopause. It requires very little comment. Undoubtedly, the lower survival rate in the post-menopausal cases is occasioned by the fact that so many of these were cases in which only a palliative operation was performed, and in those occurring during the menopause, there was such a small number that the percentage of five year survivals can vary widely.

Chart IV records graphically the size of the lump in the breast. No explanation can be offered for the small percentage (12.5%) of cases in which a lump less than one centimeter in diameter survived five years without recurrence. As would be expected, the results in the others varied directly in proportion to the size of the lump until it was between four and five centimeters when there is a slight increase in the five year salvage percentage and then a progressive drop.

Chart V records graphically the results obtained in 390 cases in which

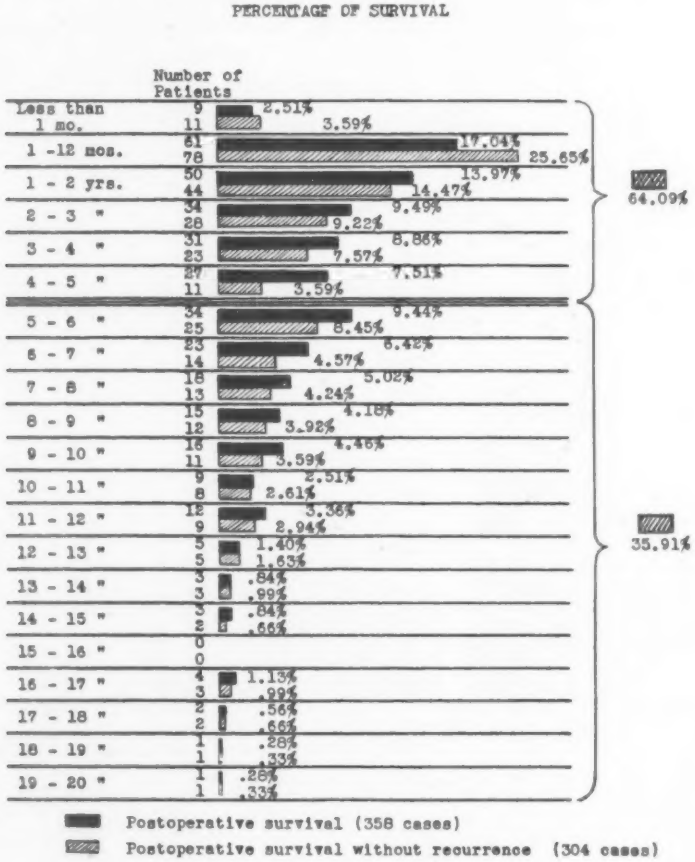

CHART 10.—Length of life after operation, with and without recurrence.

the changes in the skin were noted. The remarkable things to be noted here are that there were no five-year survivals without recurrence in any of the cases in which there was a retraction of the nipple, an orange-peel effect of the skin, or a fungating tumor without ulceration. Fixation of the mass to the skin produced a slight decrease in the five-year end results but dimpling of the skin apparently had no effect on the result obtained.

Charts VI and VII present graphically the occurrence of nodes in the axilla, noted clinically or by the pathologist. In those cases in which a clinical presence or absence of the node was recorded, there was not as great a difference in the five-year survivals without recurrence in those without nodes and those with nodes, as there was in those found by the pathologist. In the latter group, these figures correspond very closely to those in other series, namely approximately 20% in which the nodes were noted by the pathologist, and about 60% in those in which there were no nodes.

Chart VIII records graphically the results in relation to whether or not pre-operative radiation was administered. It is discouraging to note that

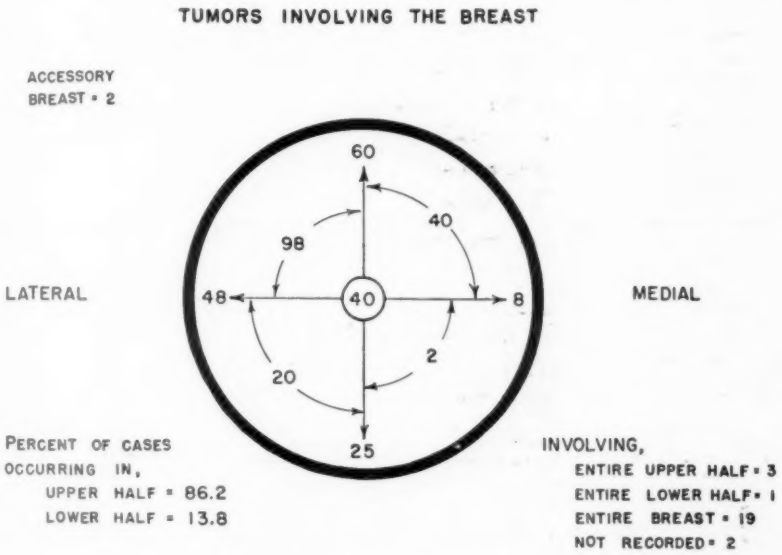

CHART XI.—Location of the tumor.

apparently a higher percentage of cases did well who had no preoperative radiation. We feel that the explanation lies in the fact that so many of those who were considered hopeless and in which palliative operations were performed, received pre-operative radiation. In spite of these figures, it is the opinion of the Steiner staff that preoperative radiation is beneficial. All of the far advanced cases, particularly those with ulcerated lesions, received pre-operative radiation. The delay between the completion of the radiation and the operation in this group of cases, was between 1 and 14 days in 25.58% (67 cases), between 15 and 28 days in 46.3% (144 cases), and over 28 days in 32.15% (100 cases). It should be stressed, in this connection, that one should decide the primary operability of a case before administering any radiation, and having made that decision, should not later alter it. Many cases obviously primarily inoperable, may later appear to become operable following radiation. A delay in operating is lamentable but we feel that the

good accomplished by radiation, namely the destruction or inactivation of the cancer cells plus the blocking of the lymphatics by scar tissue, outweighs the delay.

The occurrence of an infection was recorded in 18.38% of the 359 cases in which this fact was noted. This, of course, is a very unusually high rate of infections. However, there were 52 cases in which an ulcerated lesion was present. In many instances, the apparent infection was really a slough produced by the electrosurgical unit used in many cases. The use of this unit, undoubtedly, increases the instance of sloughing and infections and delays wound healing. If 52 cases who had sloughing lesions are deducted, the infection rate drops to 4%. Table III records that the infection

TABLE IV.—*Use of Skin Grafts (364 cases)*

1. None used	89.29%
2. Primary grafts	2.74%
3. Secondary grafts	7.97%

TABLE V.—*Wound Healing (245 cases)*

	Per cent	
Less than 7 days	4.49	24.49
8—10 days	4.49	
11—14 days	15.50	
15—21 days	22.89	
22—30 days	13.06	
31—60 days	25.70	
Over 60 days	13.87	

rate is apparently higher in those undergoing radical mastectomy who had had preoperative radiation than those who did not have it, but it is distinctly higher in those who did not have preoperative radiation and who underwent a simple mastectomy. Here, the group is such a small one that the figures can easily be distorted.

Table IV records the percentage of cases in which skin grafts were employed. Not as many skin grafts were used in this series as are reported in others for several reasons. In the first place, following preoperative radiation or the use of the electrosurgical unit, the primary skin graft is much less likely to live. For the same reason, failures to obtain a living graft in the secondary grafts were frequent.

Table V records the length of time required for wound healing in the 245 cases in which this information was available. Approximately 25% of the wounds were healed in 2 weeks, another 25% in an added week. The delay in wound healing is undoubtedly due to three factors, pre-operative radiation, the use of the electrosurgical unit, and failure to use skin grafts primarily.

TABLE VI.—*Pathologic Diagnosis (414 cases)*

Diagnosis	%	Axillary Nodes		Type of Operation				5-Year Survival				5-Year Survival without Recurrence			
		Yes	No	Radical	Simple	Simple & axillary nodes	Excision of mass	Radical	Simple	Simple & axillary nodes	Excision of mass	Radical	Simple	Simple & axillary nodes	Not recorded Excision of mass
Scirrhous, Sclerosing or Fibrous	26.81	45.45	54.55	83.03	10.71	5.35	..	12.53	10	16.67	..	32.5	none	none	100
Carcinoma—Simplex	24.18	50	50	74.75	16.44	4.85	..	44.77	6.25	40%	..	37.1	none	33.33	0
Adeno-carcinoma	20.29	53	47	72.43	21.62	5.4	..	55.33	45.45	....	..	46	50	none	none
Alveolar	10.38	63.33	36.67	66.67	28.57	2.38	..	52.17	33.33	....	..	35.83	16.67		
Duct—Tubular	9.66	22.22	77.88	84.61	12.82	2.56	..	52.13	100	..	..	55.56	100		
Medullary	1.93	75	75	100	....	....	..	40	....	....	..	66.67			
Gelatinous	1.93	57	43	75	12.5	12.5	..	75	....	....	..	75			
Padgets	2.17	14.28	85.72	4.45	5.55	....	..	33.33	60	....	..	33.33	75		
Comedo	1.2	50	50	60	20	....	20	33.33							
Sarcoma	.96	33.33	66.67	50	25	....	..	100	....	....	100	100			

TABLE VII.—*Postoperative Use of Arm (265 cases)*

	Radical (208)	Simple (43)	Simple and Axillary (10)	Excision of mass only (1)
Excellent	78 (37.5%)	15 (34.88%)	1 (10%)	1 (100%)
Good	61 (29.33%)	21 (48.84%)	7 (70%)	
Fair	46 (22.11%)	4 (9.3%)	0	
Poor	23 (11.06%)	3 (6.98%)	2 (20%)	

TABLE VIII.—*Swelling of Arm (236 cases)*

	Radical (230)	Simple (43)	Simple & Axillary (9)	Excision of mass only (1)
None	129 (56.05%)	38 (88.37%)	7 (77.78%)	1 (100%)
Slight	53 (23.04%)	1 (2.33%)	0	
Moderate	32 (13.92%)	3 (6.97%)	1 (11.11%)	
Severe	16 (6.99%)	1 (2.33%)	1 (11.11%)	

Table VI presents the cases grouped according to the pathologic diagnosis, and in the first column, divides them into the percentage of each diagnosis in the total of 414 cases. Next is presented the occurrence of axillary nodes as found by the pathologist. In the next group, is the type of operation performed in each different type of carcinoma, and in the next group, the five-year survivals, and the last group, the five-year survival without recurrence. Perhaps too much detail has been combined in this one table but the important figures are in the first and last groups, namely the five-year survival without recurrence in each type of carcinoma.

Chart IX presents graphically the types of operations performed with the five year survival rate and the survival without recurrence in each type of operation. Of the 90 simple mastectomies or simple mastectomy with axillary nodes removed, 76 were done as palliative procedures. This, of necessity, reduces the percentage of cases in the five-year cure groups. We feel that in some cases it is better to do a simple mastectomy than a radical. The patient should be treated as an individual. No routine management

TABLE IX.—*Length of Hospital Stay (258 cases)*
(11 died in hospital and 148 are not recorded)

	Per Cent
1— 5 days	5.52
6—10 days	41.09
11—14 days	21.36
15—21 days	19.14
22—30 days	5.18
Over 30 days	7.71

should be used in all cases. In patients who are 70 years of age or older, or in those whose general health would not justify a radical operation, or in cases of a known low grade malignancy in an older person, a simple mastectomy is recommended rather than a radical. The life expectancy in these patients is so much shorter than that of a younger patient and the added strain of the radical operation jeopardizes her welfare more than the possibility of having a recurrence of the tumor. This is a dangerous statement to make, for some might use it as an excuse for not doing the more radical operation. We feel, however, that in those cases surviving five years without recurrence, it is perhaps due to other causes than our efforts. The good results depend more upon the nature of the tumor and the resistance of that particular individual against tumors, than to any other factors. There have been cases which clinically appeared to be very malignant and which were reported by the pathologist as being quite cellular and likely to return both locally and at distant points, and who are living as long as 15 years. On the other hand, there was one patient who was considered as being inoperable, who had numerous nodules in the skin and the lesion in the breast was about to ulcerate. She was given a preoperative cycle of roentgen-

ray treatments and told to return for her radical mastectomy. She failed to return, was seen again five years later still living, but, of course, with her cancer rather active. Had she been operated on, by either a radical or simple mastectomy, that operation probably would have been credited with giving the five-year cure. In the cases who died from the operation, many would have survived had they had a simple mastectomy rather than a radical one, particularly among the older age groups.

Table VII records the use of the arm at discharge and the eventual use of the arm and requires no comment. Table VIII records the post-operative use of the arm and the swelling of the arm. These require very few comments other than to state that there was a higher percentage of cases who had

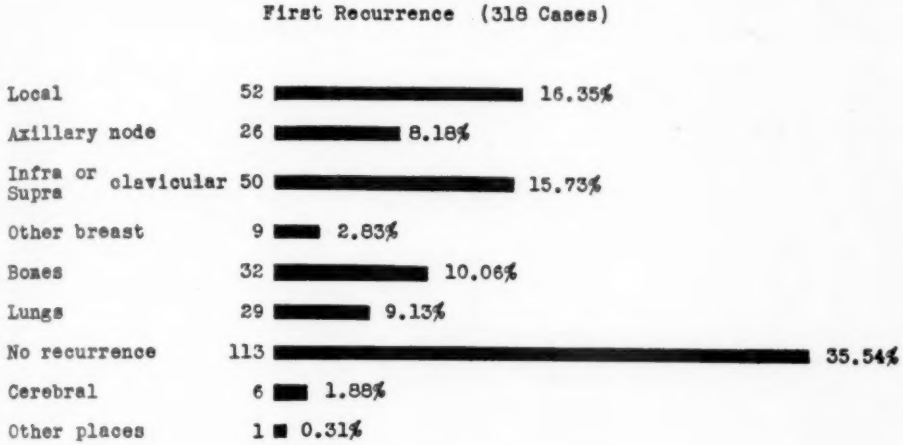

CHART XII.—The site of recurrence.

radical mastectomy and no swelling of the arm, than was anticipated. As a rule, a patient who is to have a radical mastectomy and a thorough axillary dissection will have some swelling of the arm. Table IX presents the length of the hospital stay and needs no comment other than to remind one that in dealing with clinic cases, they are more prone to "like" hospital life, and are also frequently kept for the convenience of the House staff.

Chart X represents the length of life after operation, both with and without recurrence. The five-year survival without recurrence of approximately 36% is somewhat lower than is given in most series, but is accounted for by the conditions which have been previously noted: the inclusion in this series of 76 cases who had nothing more than a palliative simple mastectomy, sometimes with the removal of some of the lower axillary nodes, and of many instances, in which the operation was performed in spite of distant metastases. A careful examination of this chart will give the percentage of survivals for each number of years postoperatively. There was only one patient, who has now lived for 20 years since her radical mastectomy; one is living 19 years after, and two, 18 years after.

Chart XI records the location of the tumor. As in our previous report, and in most other series, the vast majority of carcinomas occur in the upper outer quadrant. Of these, 86.2% were in the upper half of the breast. One of us (W.P.N.) has previously offered as an explanation for the occurrence of so many of the carcinomas in this location of the breast, and of the pre-existing mastitis, the fact that the breast is not properly supported when a woman assumes the upright posture. To help prevent this, we feel that a good brassiere is a necessity and will do much toward preventing cancer of the breast. Such a brassiere should have two straps in front, the lateral strap giving the support to that portion of the breast which is most frequently

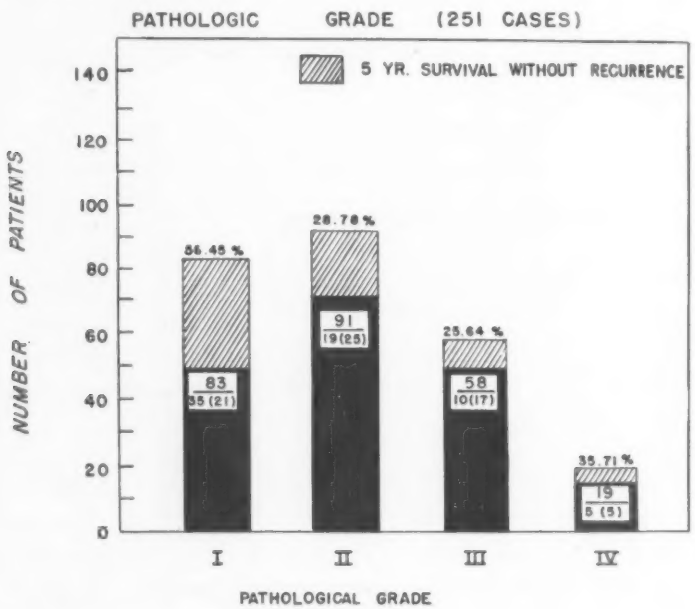

CHART XIII.—Results grouped according to the pathological grading of the tumors.

affected. Spencer, Inc. is cooperating in this effort and makes a very satisfactory brassiere individually designed and fitted.

Nine deaths occurred within one month of operation. This is a rather high percentage, namely 2.16. The cause for death in these cases was in 3, a massive infection of the wound with general septicemia or purulent endocarditis. In 2 cases, consciousness was never regained. One of these, apparently, had signs of a cerebral hemorrhage. The other had had only a palliative simple mastectomy and, in each case, they survived only three days. Two cases developed mesenteric thrombosis as proven at autopsy. One had diabetes and a generalized sepsis and died on the 22nd postoperative day, and another died on the 9th day from a coronary thrombosis. Only one of these was less than 50 years old and four were over 60.

No hormonal therapy had been used at Steiner before 1942. No estrogens nor androgens were administered to any case in this series. Surgical castration was not carried out in any case. In most instances, in the pre-menopausal era, radiation over the ovaries was recommended but was frequently refused, especially by the colored patients. Only 14 cases in the pre-menopausal period received radiation to the ovaries. Eleven of these were followed for five years and 90% or 10 of the 11, were not only surviving but had no evidence of disease at the end of five years. In seven of these nodes were noted clinically, and in three involved nodes were found by the pathologist. Of the other 162 cases in the pre-menopausal era who did not receive radiation to the ovaries, 39% (56 cases) survived five years and 34% (42 cases) survived for five years without recurrence. Of the 214 post-menopausal cases, 34% (53 cases) survived five years without recurrence. In such a small group as 14 cases, one can not draw conclusions but the striking difference between a 90% five year symptom free survival compared to less than 35% is certainly significant and would apparently indicate that a destruction of the ovaries, either by surgical removal or by radiation in a person in the pre-menopausal period is to be advised and most strongly recommended.

Chart XII records graphically the site of recurrence. Over 16% (52 cases) showed a local recurrence. As a general rule, an early local recurrence indicates that the surgeon did not go widely enough from the lesion, or that the patient was one who should not have been submitted to surgery. Of these 52 cases, 39 had received preoperative radiation; in six skin grafts had been used; and 49 had received postoperative roentgen-ray treatments. In 11 of these 52, a radical operation was not performed, in three supraclavicular nodes were noted at time of operation, and in 21 the skin was ulcerated, fixed to the mass or showed orange-peel effect.

Chart XIII records graphically the results grouped according to the pathological grading of the tumors. It is remarkable to note a higher salvage rate in the grade IV lesions than in grades II and III. No explanation for this can be offered other than the relatively small number of cases in this group.

COMMENT

An analysis of the findings and results in 905 cases of cancer of the breast, of which 417 were treated surgically, has been presented. These have been grouped as to age; marital status; chief complaint; history of injury; history of discharge from the nipple; history of lump in the breast; duration of lump; number of pregnancies and lactations; menstrual abnormalities; size of lump; skin changes; involved axillary nodes; preoperative radiation; infection; use of skin grafts; wound healings; use of arm; swelling of arm; pathologic diagnosis; type of operation; location of tumor; radiation to ovaries; and the mortalities analysed.

CONCLUSIONS

No definite conclusions can be drawn from a study of such a series, but certain facts are strongly suggested:

1. The relatively young patient isn't more hopeless than the older ones.
2. Pain in the breast is rarely the presenting chief complaint.
3. There was no history of familial cancer in over 75% of the cases.
4. 80% gave no history of injury to the breast.
5. 88% gave no history of a nipple discharge.
6. 93.5% gave a history of a lump in the breast; of which 25% had existed more than a year, and 14% more than two years: only 11% were seen in less than a month after the lump was discovered.
7. One third of the cases had had no pregnancy or lactation.
8. Abnormal menstrual histories were noted in only 10% of the cases.
9. The size of the lump apparently had a definite bearing on the result except in the small lumps (of which there were only 10), and those between four and five centimeters. No explanation is offered for the relatively better results in the latter group.
10. No case which had either a retraction of the nipple, or an orange-peel skin, or a fungating tumor was salvaged for as long as five years. Best results were obtained in those cases showing no changes in the skin, or a dimpling of the skin.
11. Those cases who received no preoperative radiation showed about a 7% higher salvage rate.
12. In carefully selected cases a simple mastectomy with removal of the lower axillary nodes is advocated rather than doing a more radical operation.
13. The postoperative swelling of the arm is not noted in as many cases as previously supposed.
14. Proper support of the breast by a good brassiere is probably a good prophylactic measure against so-called chronic cystic mastitis, and perhaps carcinoma.
15. Destruction of the ovaries either surgically or by radiation in the younger women apparently definitely enhances their chances of survival.
16. 36% survived five years or more without recurrence and an additional 5% lived that long but had recurrences.

Appreciation is expressed to the Georgia State Department of Health, and to Mr. Garvin and Mr. Ezelle in particular, for assistance in tabulating results and determining percentages.

DISCUSSION.—DR. THOMAS C. DAVISON, Atlanta: Some time ago I reported a series of cases from the Georgia Baptist Hospital in Atlanta, and the Sheffield Cancer Clinic, in which I divided the cases into private patients and clinical patients. I found that in private patients there was a five-year survival of 50 per cent, and in the clinical patients there was a five-year survival of only 28 per cent. One would expect a difference, but I was surprised that it was so great. The private patients are more intelligent, seek treatment earlier and take advice more readily; while clinic patients neglect themselves and are not inclined to take advice when given.

I would like to put in a plea for the derelict breast cases with metatases, both bony and soft tissue metastases, following operation. Recently at the Sheffield Clinic we have been using the male sex hormone, testosterone, to treat these apparently hopeless cases. We have a series under treatment now, and in certain instances have had almost startling results. Two cases who came in on crutches, after having been given 50 mg of testosterone daily for several doses, threw away their crutches, while two others who were taking morphine for pain, voluntarily stopped its use; others gained weight, felt much better and improved in every way. In some cases with bony metastases the x-ray showed recalcification, while still others died in spite of treatment. This remedy is not a cure, and its use is still in the experimental stage. We are not claiming anything in the way of a cure but simply give you the facts for what they are worth. Its use in these patients has been likened to a person jumping out of a plane without a parachute as compared to one with a parachute — it lets them down easy. There is one objection to this treatment; some of the women sprout a mustache and develop a hoarse voice.

Dr. Edgar D. Grady, Atlanta: Recent developments in the treatment of cancer of the breast by hormonal therapy make it appropriate to re-emphasize the facts brought to light in this review, showing the possible relationship of sex hormones in the genesis and regulation of breast cancer. It has been shown experimentally that oophorectomy in strain C-314 mice reduced materially the incidence of cancer of the breast. In a similar strain of mice which had a high susceptibility to cancer of the breast, administration of androgens has decreased the incidence of spontaneous breast cancer.

We found that the greatest number of cases of cancer of the breast appeared near the menopausal age; 246 cases were between the ages of 41 and 60, while there were 90 cases in the age group of 40 years and under; 81 were in the age group of 60 years or more. Carcinoma of the breast thus appears to be most frequently a disease of the involuting breast, a breast in which the hormonal influence has recently been changed.

Of the 10 per cent of our cases who had abnormal menstrual histories, only 16.3 per cent survived five years without recurrence, compared with 39 per cent survival without disease in the cases who had normal menstrual histories. The abnormality of menstrual history demonstrates the disturbance in the patient's production or regulation of her sex hormones. The response of menstruation to hormonal stimulation was unusual, and her breast cancer was also unusual.

In the 11 pre-menopausal patients who received radiation castration and who were followed for five years, 10 of the 11 had no evidence of disease at the end of that five-year period.

We feel, then, that breast cancer is an endocrine problem as well as a surgical and radiologic problem. It is our aim to give greater hope to the woman with breast cancer through early diagnosis, improved therapeutic measures and improved palliative therapy.

Dr. Isidore Cohn, New Orleans (closing):* Since Dr. Nicholson has emphasized that their patients are getting pre-operative radiation, I want to make it clear that we have not used, so far as I know, preoperative radiation; I know this has been done in none of my cases. These patients who come in on an average of a year and a half after symptoms I waste no more time on; it has been long enough already.

When we say 62 per cent had lymph nodes in the axilla, I meant that they were palpable. Recently I operated on a patient in whom I could palpate no lymph nodes, but the pathologist found carcinoma cells in three out of 24 small lymph nodes.

I have had less trouble since using the transverse incision (Stewart) in the last thirty years, so far as arm movement is concerned.

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* Dr. Cohn's paper "Further Study of Carcinoma of the Breast in the Negro" will appear in the Southern Surgical Transactions, Vol. 59, 1947.

RATIONALE AND RESULTS IN RETROPUBIC PROSTATECTOMY*

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FROM THE UROLOGICAL DEPARTMENT OF THE UNIVERSITY OF LOUISVILLE.

THREE METHODS OF REMOVAL of the prostate gland have been recognized up to recent months. No one of these has been wholly satisfactory, and each has been characterized by several very unfavorable features. It is in no wise the purpose of this paper to enter into a controversy of the relative merits of these three methods, but in order correctly to determine the value of Retropubic Prostatectomy it is necessary briefly to review the shortcomings of the three standard types.

The suprapubic operation has the highest mortality, it requires passage through the bladder mucosa twice in order to reach a gland which, in truth, lies entirely outside the bladder. The enucleation of the gland is done blindly, and it necessitates rubber bags and packs to control the hemorrhage. In addition, it offers no possibility of removal of a carcinomatous gland which has invaded the capsule.

Transurethral resection seems to us a procedure well adapted to small glands and median bars and for purely palliative treatment in the inoperable obstruction of carcinoma. Faith in its further extension however is maintained by some excellent urologists, but since the first fanfare of its introduction it has lost many of its hardy enthusiasts. Likewise, its mortality in large glands is very high except in the hands of very excellent resectionists. Its morbidity is prolonged by the necrosing of tissue electrically treated, stricture of the urethra is a frequent sequela and an enormous percentage of resections have to be repeated later or the glands removed by surgical methods because of remaining or recurring adenomata. Like suprapubic prostatectomy, the resection is unsuccessful in the radical removal of prostatic carcinoma and is far more likely to leave intracapsular malignancy than even suprapubic enucleation.

Perineal prostatectomy is truly a surgical operation, the gland being enucleated under direct vision, hemorrhage being completely controlled by suture. It has the lowest mortality of the three recognized methods when large glands are removed. It also possesses a great advantage in that it is readily applicable to removal of the malignant prostate which has involved the capsule. The postoperative morbidity is low and the patients have a minimum of surgical shock. However, it has its serious drawbacks as well. The position on the operating table is a definite strain on the patient, it requires trained surgical skill and a thorough knowledge of perineal anatomy, a cooperatively trained team and considerable special equipment. Even in skilled hands there is frequently some temporary incontinence from a few days to a month or two; and in inexperienced hands the results are terrible, persistent fistula, injury to the rectum and complete incontinence being very

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Wednesday, December 10, 1947.

frequent sequelae. In a great majority of patients sexual potency is lost or much impaired.

The operation of Retropubic Prostatectomy as devised and described by Mr. Terence Millin, a famous urologist in London, has a completely new approach. The space of Retzius has been anathema to urologic surgeons since the beginning of suprapubic procedures on the bladder, and indeed at least six different methods have been devised by advocates of suprapubic prostatectomy to seal off or occlude this space of historical potential danger when operating. Nevertheless it is directly through this space that the new approach to the prostate has been made, and apparently the stone rejected of the builders has become the chief cornerstone.

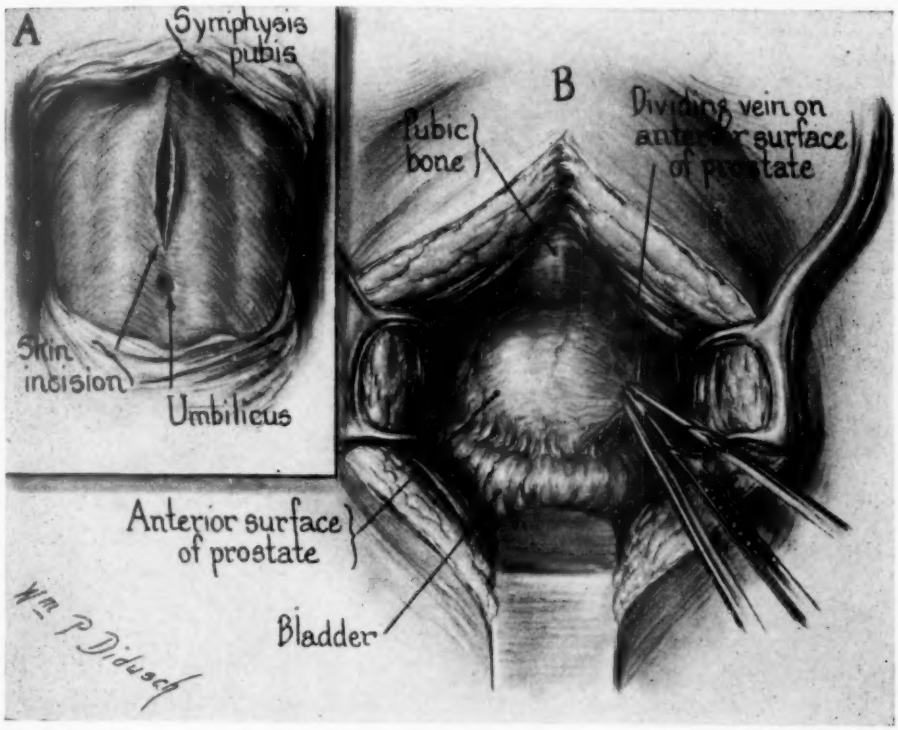


FIG. 1.—(A) Skin incision.
(B) Exposure of vessels in adipose tissue covering the prostatic capsule.

The technic of the procedure is shown in Figures 1 to 5. The skin incision may be vertical or transverse, at the present time we prefer the transverse for better healing. The skin and subcutaneous fat are incised to the rectus sheath which is then likewise cut transversely and the recti muscles separated. The insertion of a two-blade retractor then thoroughly exposes the field. In the wound can be seen the space beneath the pubic arch, the preprostatic layer of fat which ordinarily occupies the space of Retzius and the vessels

coursing through this fat. A third blade of the retractor is then introduced to push back the previously emptied bladder. Then on each side of the prostate, now covered with the fat and tissue containing the vessels, a gauze pack is introduced well under the pubic arch region and practically up to the posterior layer of the triangular ligament. These two packs are to isolate the prostate and more accurately to define its extent. The vessels in the tissue over the prostate are then ligated with sutures. They consist usually of two or three distinct branches and can be readily seen. The sutures ligating these vessels should be carried deeply by the needle even to entering the capsule. A pair of curved long blade Mayo scissors are introduced into this incision and the prostatic adenoma loosened from its bed and the

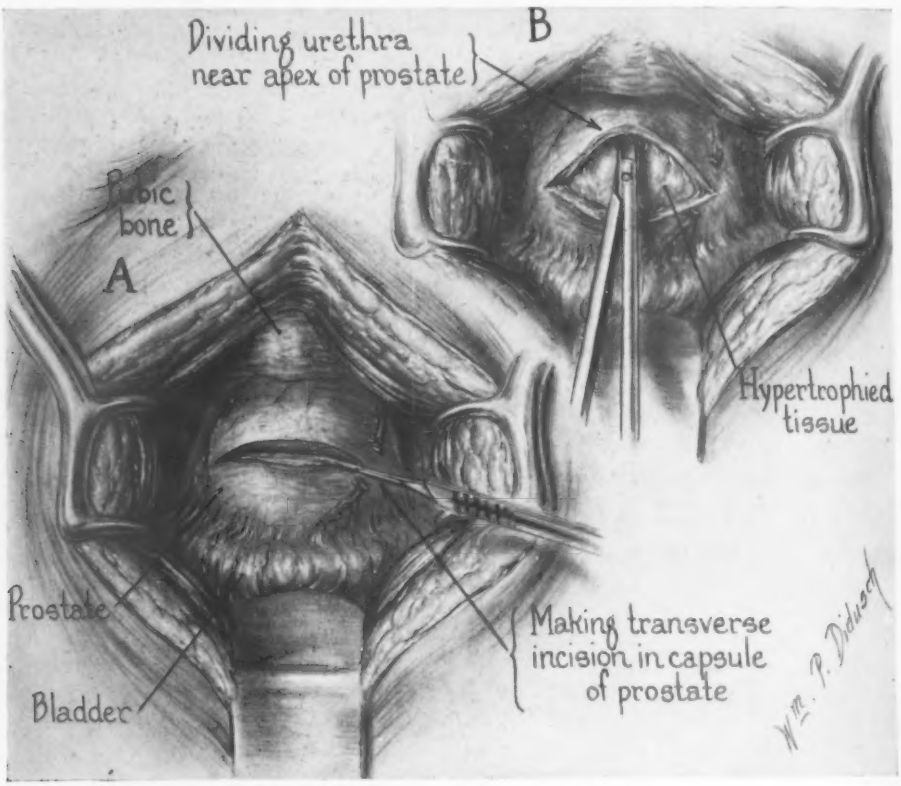


FIG. 2.—(A) Incision in the capsule between the ligated vessels.
(B) Division of the urethra at the apex within the prostatic capsule.

urethra cut across near the prostatic apex. The gland is then enucleated, beginning at the apex *toward* the bladder. This is done either with the finger or with the blunt scissors. When the enucleation has reached the vesical neck, the gland is lifted well into the wound and separated from the bladder by blunt dissection. As the gland is peeled off the bladder the prostatic

arteries, which usually are located at the lower sides of the vesical neck, can frequently be seen and caught by clamps even before the gland is completely freed. The enucleation is then finished, and if the prostatic arteries have not been already caught, they are readily seen and are ligated with a figure of eight sutures which extends into the base of the capsule. We consider this step extremely important and to it attribute our minimal loss of blood at operation and the clear urine postoperatively. In our early cases we did not secure these vessels so carefully and definitely determined that the one case of postoperative bleeding came from this area. The lateral packs are now removed.

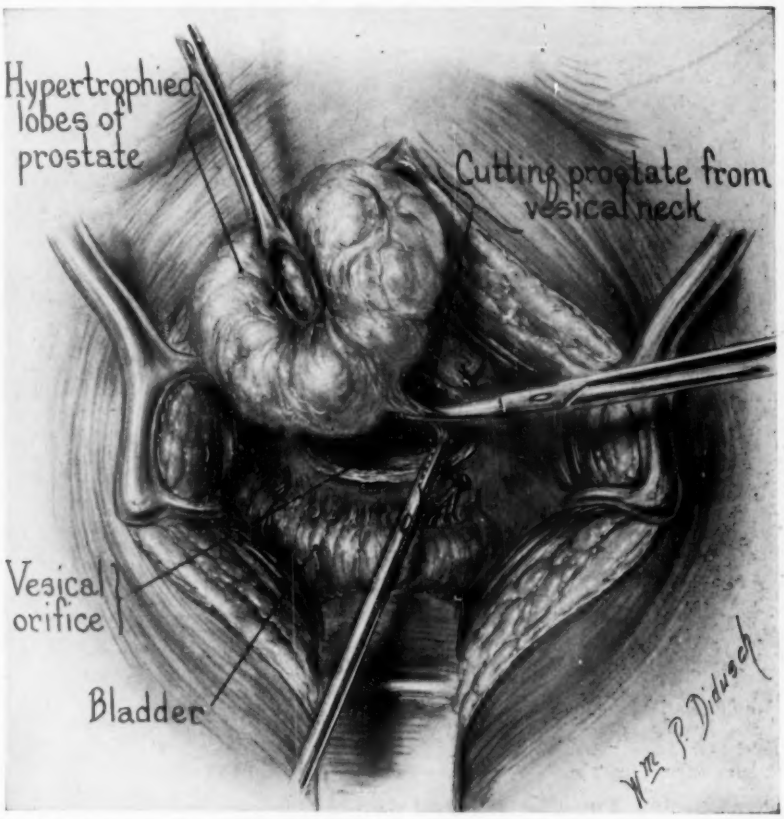


FIG. 3.—The enucleated gland delivered being trimmed from the vesical neck.

The bladder is digitally examined for calculi or diverticula. Five of our cases were complicated by vesical calculi, in two cases large multiple ones which were readily removed through the vesical neck by means of forceps. With the exception of dilating the mouth of diverticula, we have done nothing toward correcting this condition but it is well to recognize the presence of diverticula, since they may cause some amount of residual urine postoperatively. Of three cases with diverticula two required considerable lavage postoperatively before they cleared.

The bed from which the gland has been enucleated is inspected under direct vision for any stray nodules or tags. If the gland has been neatly and completely removed, the prostatic bed is dry. A catheter is then introduced from the meatus and passed into the bladder. This is then gently irrigated to wash out any clot or detritus. The cut surfaces of the capsule are drawn together with sutures passing well into each side. We now use continuous

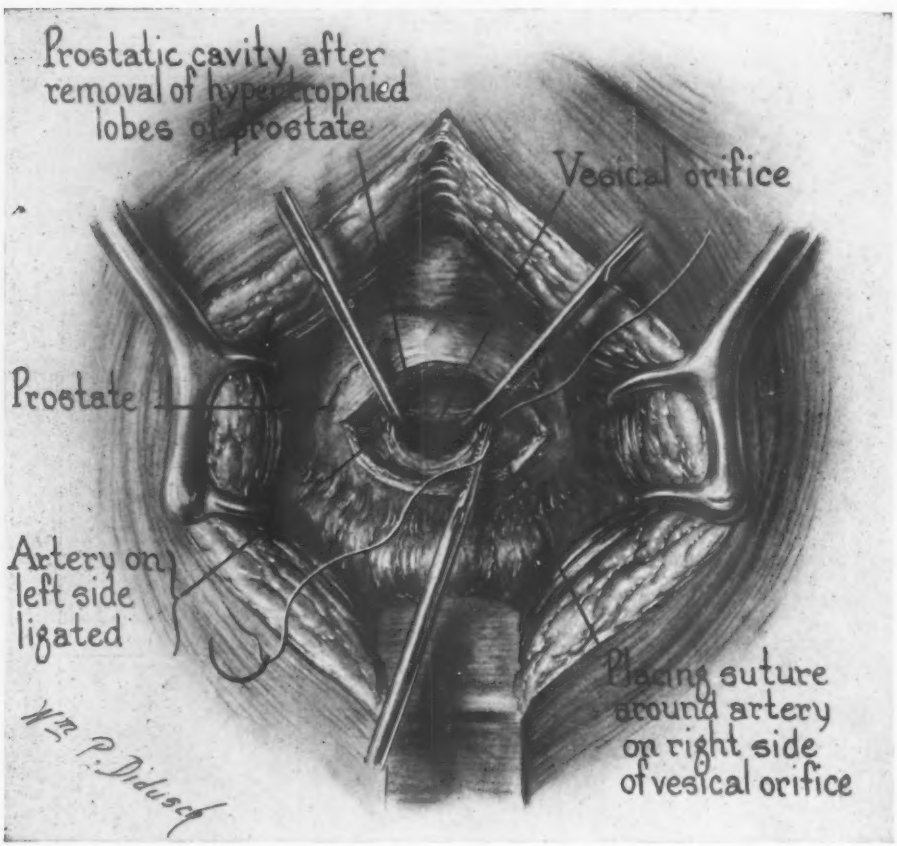

Prostatic cavity after removal of hypertrophied lobes of prostate
Vesical orifice
Prostate
Artery on left side ligated
Placing suture around artery on right side of vesical orifice
Wm P. Didusch

FIG. 4.—Ligation of the prostatic arteries.

sutures for this purpose. The wound should be perfectly dry. It is important to carry these capsular sutures well into the angles, since it is usually at this point vessels may be present that were not caught in the sutures taken prior to incision of the capsule. A small piece of rubber tissue is introduced to the suture line in the prostatic capsule to care for any serious seepage and the wound closed completely about this tissue drain. The drain is removed usually on the second or third day.

In performing radical prostatectomy retropubically, the steps are the same up to the point of incision in the capsule. After the veins have been ligated the fatty tissue is retracted and the puboprostatic ligaments come readily into view. These are severed and the prostate at its apex is quite free. The apex is cut across at the triangular ligament and turned toward the bladder with the capsule intact. This readily separates from the rectum and

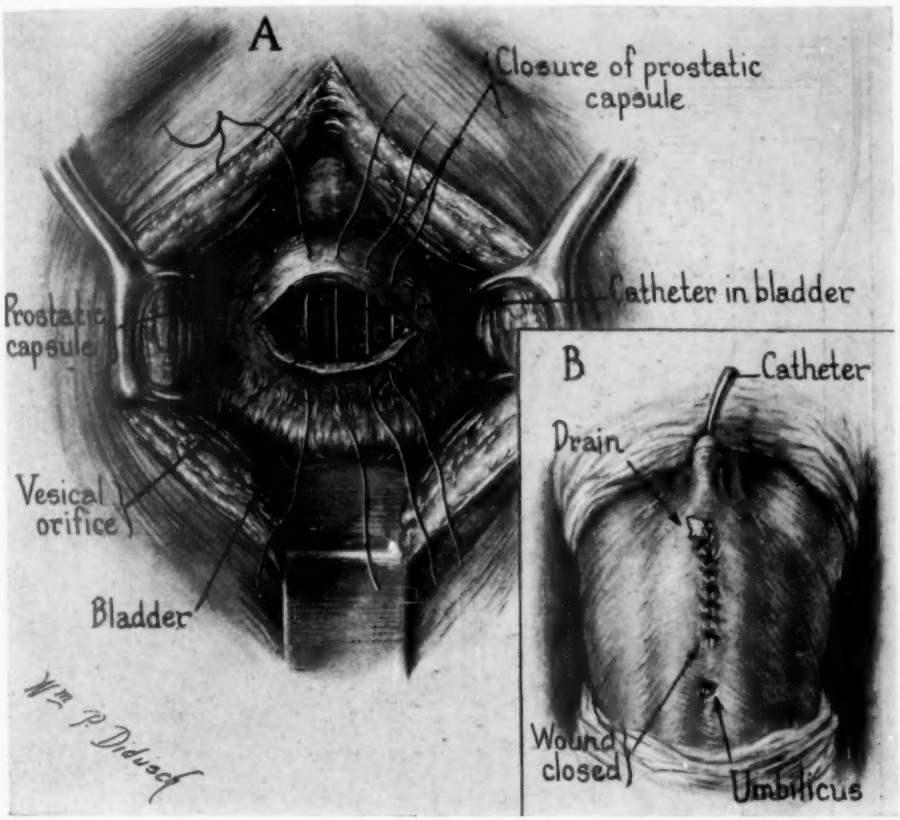


FIG. 5.—(A) Closure of prostatic capsule over a retention catheter. (B) Skin closure with cigarette drain.

the seminal vesicles are clamped and removed with the intact prostate if desired. It is wise to remove vesicles in carcinoma perhaps, but in the fibrous prostate, especially those with calculi which are removed with the capsule intact, extirpation of the vesicles is not necessary. The gland is then cut free from the bladder neck and the bladder neck anastomosed to the distal urethra. We found that when the pubo-prostatic ligaments are cut the length of the distal urethra is fully sufficient for anastomosis to the bladder neck.

Our series is too brief, fifty cases, and the time elapsed, 5 months, too short for final judgment, but to date we have been so pleased in every respect

TABLE I.—*Detailed Analysis of 50 Cases of Retropubic Prostatectomy*

Date			Patient	Type Prostate	Drainage Period	Catheter Period	Pathologic Findings	Complications	Post Operative Stay	Age	Remarks
Mo.	Day	Yr.									
5	3	47	C.B.	Trilobe +++	4 Days	6 Days	Benign	None	10 Days	65	
6	26	47	E.K.	2 Lateral	4 Days	4 Days	Benign	None	11 Days	69	
7	5	47	J.N.	Trilobe +++	14 Days	14 Days	Benign	None	20 Days	65	Prostatic calculi, large vesical diverticulum.
7	5	47	J.B.	Trilobe +++	4 Days	6 Days	Benign	None	12 Days	74	A marked phimosis.
7	12	47	J.F.	Fibrotic	4 Days	6 Days	Benign	None	10 Days	72	Prostatic stone.
7	15	47	W.C.C.	Trilobe +++	14 Days	8 Days	Benign	None	30 Days	76	Suprapubic drainage 5 mos., preliminary. Grave kidney deficiency. Recovery complete.
7	16	47	J.H.	Trilobe +++	3 Days	6 Days	Benign	Cerebral accident	10 Days	75	Cerebral accident, 2nd post-operative day.
7	19	47	C.S.	Trilobe	3 Days	6 Days	Benign	None	15 Days	64	
7	22	47	M.R.	Trilobe	4 Days	6 Days	Benign	Calculus	13 Days	80	Calculus vesical, 5 x 5 x 3 cm.
7	25	47	A.G.	2 Lateral	17 Days	17 Days	Benign	Diabetic	22 Days	74	Long drainage, probably occasioned by diabetes.
7	26	47	J.E.	Bilobe	3 Days	6 Days	Benign	None	14 Days	78	
7	29	47	J.B.	Trilobe ++	4 Days	5 Days	Benign	None	13 Days	76	Vesical calculus, 2½ x 1 x 2½ cm.
7	29	47	H.V.	Bilobe ++	10 Days	10 Days	Benign	Bleeding	28 Days	73	Re-opened and drained wound.
8	5	47	C.B.	Bilobe	2 Days	6 Days	Benign	None	9 Days	76	Vesical calculus.
8	6	47	I.H.	Trilobe	4 Days	7 Days	Benign	None	10 Days	67	
8	7	47	M.C.	Trilobe	3 Days	7 Days	Benign	None	9 Days	67	Three stones, 2 x 2 x 2 cm.
8	16	47	N.G.	.....	1 Day	5 Days	Benign	None	8 Days	62	None
8	30	47	L.F.	Trilobe	3 Days	6 Days	Benign	None	8 Days	67	
8	30	47	S.S.	Trilobe ++	4 Days	7 Days	Benign	Large diverticulum, occasioned leakage.	14 Days	71	

TABLE I.—(*Continued*)

Date			Patient	Type Prostate	Drainage Period	Catheter Period	Pathologic Findings	Complications	Post Operative Stay	Age	Remarks
Mo.	Day	Yr.									
9	3	47	G.H.	Small Median Lateral	3 Days	7 Days	Benign	Hypoproteinema	15 Days	77	Hospital stay prolonged on account of delayed wound healing.
9	5	47	R.C.	Trilobe	2 Days	5 Days	Benign	None	10 Days	60	
9	6	47	J.P.R.	Trilobe	2 Days	6 Days	Benign	None	8 Days	64	
9	9	47	A.A.	Fibrotic	3 Days	10 Days	Benign	None	12 Days	57	Radical prostatectomy, removing capsule.
9	9	47	C.S.	Trilobe +++	2 Days	8 Days	Benign	None			
9	17	47	F.D.	Trilobe	3 Days	7 Days	Benign	Secondary hemorrhage	11 Days	67	Secondary hemorrhage, twice.
9	18	47	C.P.	Bilobe	2 Days	5 Days	Benign	Hemorrhage	12 Days	58	Secondary hemorrhage, 7th postoperative day.
9	18	47	M.T.	Trilobe	2 Days	5 Days	Benign	Hemorrhage	15 Days	74	Secondary hemorrhage, day of operation.
10	9	47	S.R.	Trilobe	2 Days	5 Days	Adeno carcinoma	None	11 Days	67	Adenocarcinoma, Grade I to II.
10	9	47	E.D.M.	Trilobe	3 Days	6 Days	Benign	None	14 Days	65	
10	11	47	W.G.D.	Bilobe	2 Days	6 Days	Benign	None	11 Days	62	
10	11	47	F.N.D.	Bilobe	2 Days	7 Days	Benign	None	6 Days	63	
10	16	47	D.G.	Trilobe	1 Day	4 Days	Benign	None	6 Days	59	
10	23	47	L.T.	Trilobe	2 Days	5 Days	Benign	None	8 Days	62	
10	25	47	L.B.	Bilobe	2 Days	5 Days	Sarcoma	None	6 Days	71	
10	28	47	H.G.	Trilobe	2 Days	8 Days	Benign	None	25 Days	63	Thrombophlebitis.
11	10	47	A.R.	Bilobe	2 Days	2 Days	Benign	None	10 Days	65	
11	11	47	A.G.	Bilobe	1 Day	3 Days	Benign	None	7 Days	67	
11	11	47	W.S.	Bilobe	1 Day	3 Days	Benign	None	8 Days	74	
11	15	47	G.M.	Trilobe	1 Day	3 Days	Benign	None	16 Days	82	
11	15	47	T.R.C.	Trilobe	1 Day	4 Days	Adeno-Carcinoma	None	10 Days	58	Adenocarcinoma, Grade I to II
11	20	47	J.C.	Bilobe	2 Days	3 Days	Benign	None	11 Days	83	

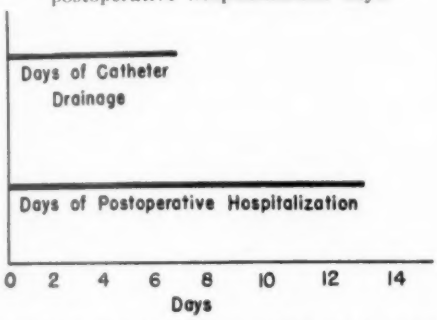
TABLE I.—(*Continued*)

Date			Patient	Type Prostate	Drainage Period	Catheter Period	Pathologic Findings	Complications	Post Operative Stay	Age	Remarks
Mo.	Day	Yr.									
11	22	47	S.M.	Trilobe	3 Days	4 Days	Benign	None	10 Days	75	
9	17	47	W.J.	Large lateral	3 Days	6 Days	Adenocarcinoma	None	11 Days	73	Bilateral orchiectomy.
9	22	47	T.M.	Trilobe	5 Days	7 Days	Benign	None	9 Days	65	
10	13	47	F.S.	Trilobe	3 Days	6 Days	Benign	None	12 Days	68	
10	27	47	A.S.	Trilobe	4 Days	12 Days	Benign	None	17 Days	57	
10	27	47	W.T.	Median Moderate Lateral	4 Days	12 Days	Benign	Infection space of Retzius	23 Days	65	Prolonged stay due to abscess space Retzius. Recovered promptly.
11	10	47	V.M.	Trilobe	3 Days	4 Days	Benign	.....	10 Days	65	
11	17	47	S.	Trilobe	2 Days	3 Days	Benign	None	9 Days	72	
11	24	47	J.M.	Small med. bi.	2 Days	3 Days	Benign	None	5 Days	71	

that we feel quite justified in calling this operation to your attention. It is in truth performed like a perineal prostatectomy upside down, having all the advantages of that procedure including ability to remove the prostatic capsule and vesicles radically when desired, without the possibility of perineal injury and the disturbance of the pelvic floor which at times occasions incontinence and sexual impotency.

Table I shows the morbidity and complications encountered. It will be seen that we met with diabetes five times, stone in the bladder four times, diverticula three times, and two radical operations were done for predetermined carcinoma. In our 50 cases we have had no mortality which, in these days of surgically performed prostatectomy is not unusual, but we have had no single fistula, no single case of incontinence which is better than our experience with any similar number of cases performed in any other manner. We have not made a complete survey of sexual potency but we have had no voluntary complaint and in 25 cases that we have questioned none have commented upon any alteration in the sexual powers from that prior to operation. With the precise control of bleeding the loss of blood is so minimal that transfusion to replace volume is not necessary. One of our earlier cases bled because we had not secured the prostatic artery, but this was controlled as soon as recognized.

TABLE II.
Summation of catheter drainage days and postoperative hospitalization days.



In addition to our own personal satisfaction with these cases, we can add that both our patients and our nurses who are astounded by the smooth postoperative course. Most patients are up the second day, postoperative, voiding without a catheter by the fifth or sixth day and ready to leave the hospital by the eighth day. (Table II). We are not prone to release a prostatectomy patient from the hospital too early, but since we have had no single case of epididymitis, one phlebitis and no serious infection, we are now dismissing most of them on the twelfth day.

No surgical method that we know of is faultless, and the removal of a diseased prostate is as little likely to present perfect results in every case as any type of surgery. Our advocacy of this method is not based on any pride of discovery or invention because indeed we theoretically criticized Mr. Millin's articles with him over a year ago and undertook the operation with little conviction of its success. Certainly at the present time we are enthusiastic disciples of his. Fanaticism for any one method of prostatectomy has been a great drawback to surgical urology for at least three decades. Every surgical urologist should be able to perform all types of prostatectomy. Only after having done many of each is he at all qualified to judge their merits

because unquestionably there is a place for each type. We have felt that no other series of fifty cases of any other type have yielded consistent results comparable to those of the retropubic route. Sufficient data and number of these cases have not been collected in this country to warrant our prophesying this procedure as the apotheosis of prostatectomy but at least we feel that if it is not the best it is better than the rest.

Since the submission of this paper for publication, we have added 45 cases of retropubic prostatectomy to the series with the same continued satisfactory results.

DISCUSSION.—DR. HAMILTON W. MCKAY, Charlotte, N. C.: Doctor Grant has said that the urologists have three standard operations and, when indicated, any one of the three gives excellent results in skilled hands. The operation described by him and advocated by Millin of London gives urologists a new approach to the prostate which offers many possibilities.

I am especially interested in diagnosis of and radical operation for early carcinoma of the prostate which will not produce temporary incontinence, and I believe that the retropubic approach to the prostate would be ideal for a radical operation. We know that in a radical perineal prostatectomy for carcinoma where the bladder is anastomosed to the urethra, patients do get temporary incontinence from a few weeks up to three months. In my opinion there is no complication which gives a patient so much concern or the urologist so much trouble as dribbling of urine.

Few of us have had an opportunity to master the technic of this operation. I am fully aware that the operation is not without complications, for such complications as osteomyelitis of the pubic bones, hemorrhage and others have already been reported, but I do believe that all urologists interested in prostatic surgery should master the technic of this operation as soon as possible.

I personally want to thank Doctors Grant and Lich for this presentation, and I am sure it will be a splendid contribution to surgical literature.

DR. HENRY L. DOUGLASS, Nashville, Tenn.: I said that I was not going to discuss this paper, but I do want to ask some questions.

The first question is on the approach: For many years, as Doctor Grant pointed out, the space of Retzius was tabu. How well can the prostatic capsule be exposed through the retropubic space, and does this approach facilitate exposure and shorten the operation as compared to the transvesical route I can see the advantages (1) of not opening the bladder and thereby avoiding prolonged drainage of urine through the wound and, (2) the avoidance of shock by better hemastasis which apparently the retropubic route permits.

Does postoperative catheter drainage adequately protect against leakage of urine into the retropubic space? If such leakage should occur, are the consequences as severe as we have in the past believed them to be?

Doctor Grant's experience with 50 cases indicates that retropubic prostatectomy has many advantages and little postoperative morbidity. It appears to be a great improvement in the treatment of prostatism, and I wish to thank Doctor Grant for bringing the operation to our attention.

MR. GUY BLACKBURN, Guy's Hospital, London, England: I should like to congratulate Doctor Grant on the series of cases he has discussed and, from my own experiences of a few cases, to add one or two points. The first is to suggest that a vertical incision is best in a thin patient for a one-stage operation, but a transverse incision may be preferable when the operation is done in two stages. Millin in fact does this. With regard to the bladder neck, some of the early cases developed strictures, requiring subsequent perurethral resection, and Millin's practice now is to cut out a V-shaped piece of bladder just above the internal meatus to avoid it.

I believe, in fact, that the Millin operation has made retropubic prostatectomy safe

for the general surgeon, provided he has special instruments, adequate light, good suction, and a diathermy apparatus. The time of operation obviously varies in different hands, but the experienced will often complete it in approximately half an hour.

DR. EDGAR BURNS, New Orleans: I would like to ask Doctor Grant a few questions based primarily on what has been the experience of some of the other American operators: First, the amount of hemorrhage lost during the operation; second, whether or not he has had any late postoperative hemorrhage as reported by a number of operators; third, whether or not any obstruction has occurred during the first few weeks or as late as two or three months; fourth, has he had any cases of osteitis pubic, which has also been reported by some of the Americans.

I do not think we can anticipate that the retropubic approach will be applicable to all cases of prostatic obstruction any more than any other method is applicable to all types. Contracture of the vesicle neck and prostatic bars can be removed easily by transurethral resection and probably should continue to be treated by that method. Perhaps 95 per cent of obstructions due to primary carcinoma of the prostate have infiltrated the periprostatic region by the time symptoms occur and do not lend themselves well to any type of open operation. On the other hand, transurethral resection for this type is ideal and will probably remain the method of choice until some non-operative cure for cancer is available. For the early carcinoma still confined to the capsule, the retropubic operation appears to offer distinct possibilities. I do not believe, however, that Doctor Grant or any other operator, including Mr. Millin, has had enough experience with this approach to early carcinoma to properly evaluate it at this time. Whatever one's approach to the benign lesions of the bladder neck may be, a good functional result is an iron-clad requirement; the morbidity should be minimal and the mortality, even on a teaching service where a large number of the operations are done by the residents, should be less than 5 per cent. We run a teaching service and expect to add the retropubic approach to the other methods already in use. Further experience may prove that the retropubic operation is better for the large benign hypertrophies and early carcinomas.

DR. OWSLEY GRANT, Louisville, Ky. (closing): We feel that retropubic prostatectomy is an added implement to the armamentarium of prostatic surgery that does things other operations will not do. We are persuaded that incontinence, temporary or not, is not due to the fact that the sphincter is injured, but to the disturbance of the pelvic floor, and this is obviated by this procedure. The removal of a wedge from the base of the bladder neck we have felt unnecessary, since we have used meticulous care to suture the bladder neck when we tie the prostatic vessels. The bladder neck suture includes a bit of capsular tissue and this fixes the neck. As to capsular involvement in prostatic carcinoma, we know some cases which at first appeared inoperable have been reduced to operable cases by the use of estrogens. No operation which is incompetent to remove the prostatic capsule can ever be considered as the sufficient operation for all types of prostatic obstruction.

Our average blood loss by hemorrhage at operation is two ounces or less. Postoperatively, the urine is pink-tinged for about eight hours and then remains entirely clear. The usual blood loss is quite negligible due to very careful suturing. We had one postoperative hemorrhage in the early cases. We employ no hemostatic tissue or solution.

No special instruments are necessary but a good boomerang needle is helpful.

The time is less than for perineal prostatectomy because exposure is so much more readily accomplished and closure is easier, since reconstruction of the pelvic floor is not required. The average time is about forty minutes.

I should not want you to think that this is a two-stage operation, as someone has mentioned a two-stage type. It is, however, equally and satisfactorily applicable if, for unusual reasons, it has been deemed advisable to drain the bladder at a preliminary operation.

So far, in our hands, retropubic prostatectomy will do anything that any other surgical prostatectomy will do, and with less morbidity or uncomfortable sequelae.

CURRENT TRENDS IN SURGERY OF THE DISTAL COLON AND RECTUM FOR CANCER*

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Choice of operative procedure in cancer of the distal colon and rectum continues to hinge upon the acceptance or non-acceptance of colostomy, either temporary or permanent, as an integral part of the procedure. This has been a debatable subject since 1839 when Amussat[1] wrote in the defense of colostomy: By 1938—when I last made a complete survey[2] of opinion in this field—most English speaking surgeons had accepted the proposition that abdominal colostomy is an essential adjunct to a proper extirpation of the rectum and rectosigmoid. Moreover, they undertook in most instances a multiple stage resection of the distal colon, such as the Rankin obstructive resection. This near unanimity of opinion developed only after many years of painstaking ground-work by such stalwart pioneers as Miles and Lockhart-Mummery and subsequent demonstration by an overwhelming array of statistical data[2] of the soundness of their principles by Grey Turner, Gordon-Watson, Abel and Gabriel in England; Wilkie and Fraser in Scotland; Graham of Toronto; and in this country, Daniel Fiske Jones, Mayo, Cheever, Rankin, Stone, T. E. Jones, Pemberton, David, Pfeiffer, Lahey, Brindley, Coller and a few others. Almost alone among general surgeons of wide experience in surgery of the large bowel at this time was Babcock,[3] who since 1932 had consistently condemned any procedure which required abdominal anus.

The tide of opinion, influenced by several factors, began to turn by the end of the last decade. Those surgeons who are unable to become reconciled to a colostomy life for their patients were prodded to unusual activity by the stimulus of the pathologic researches of Gabriel, Dukes and Bussey (1935),[4] Gilchrist and David (1938),[5] and Coller and his coworkers (1940)[6] in which it was determined that the inferior zone of spread of malignancy through the lymphatic channels in cancer of the rectosigmoid and rectum was relatively meager. Commenting on the findings of Dukes, Lynch in 1938[7] expressed an opinion in which many other surgeons were soon to concur. "It permits," stated Lynch, "one to discard entirely such radical and unnecessary operations as that popularized by Miles."

Another factor has been the tremendous gain in popularity of surgery of the large bowel as compared with a decade ago when relatively few undertook all the surgery in this field. Now almost every young general surgeon and an increasingly greater number of proctologists, on completion of their residencies, consider themselves fully qualified to perform this type of surgery. The necessity of re-exploration of the question of colostomy has been

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recognized both by this new generation and also by a considerable number of the older general surgeons and proctologists whose interest in resections of the colon and rectum for cancer was late in developing.

Many of us who served in the Armed Forces returned to civilian practice completely confused by the tangled web of endeavor in this field. It was difficult to determine the true status of treatment for carcinoma of colon and rectum. A few surgeons had published articles unequivocally accepting sphincter-saving operations as the procedure of choice. Others, notably Wangensteen,[8] were less positive as to the ultimate merits but were, nevertheless, favorable to these measures, primarily it would seem because of a decided personal aversion to colostomy. Few who were pre-eminent in this field had recently published their opinions.

In order to clarify this situation, preliminary to revision of our monograph[2] on cancer of the large intestine, Dr. Rankin and I sent questionnaires to surgeons in this country, Canada and Great Britain. In addition to questions dealing with the choice of operation for cancer of the distal colon, rectosigmoid and rectum, inquiries were made concerning the employment of complementary proximal drainage and chemotherapy. An inquiry of this nature would presumably be of greater significance if restricted to an analysis of the views of surgeons with relatively large and prolonged experience in the treatment of cancer of the large intestine. Where differences of opinion among colleagues in a few of the large institutions existed, their separate views have been recorded. On the other hand, in many instances opinions of qualified colleagues were identical, in which circumstance only the conclusions reached by the group were tabulated. Actually, therefore, the 50 expressions of opinion analyzed in this survey are representative of a somewhat larger number of individual surgeons. The department of surgery of 31 medical schools and seven clinics are represented.

It occurred to me that the value of this survey would be enhanced if the opinions of a few surgeons, generally considered leaders in this field, were contrasted with those of the remainder of the group. Accordingly, ten were selected whose pre-eminence few would question. Each has had a large experience which has extended over a period of more than 15 years. The results of this survey will be considered question by question.

IN APPROXIMATELY WHAT PERCENTAGE OF CASES OF CANCER OF THE LEFT COLON DO YOU PERFORM PRIMARY ANASTOMOSIS AFTER RESECTION? DO YOU EMPLOY OPEN OR CLOSED METHODS?

A study of answers to these questions revealed a decided trend away from extraperitoneal, multistage operations and a tendency toward more frequent use of the closed method of anastomosis. Three indicated that primary suture was undertaken only on rare occasion. Four others claimed a hundred per cent performance. The varied incidence of performance is recorded in Table I as well as the relative frequency of employment of the closed and open technics of anastomosis.

Sixty-two per cent of the combined groups estimate that they use primary anastomosis in 75 to 100 per cent of cases; 36 or 72 per cent of them use this method in 50 per cent or more of cases. In the smaller group 60 per cent believe they employ this method in less than 25 per cent of instances; the remaining four estimate a performance of 90 per cent or better. Sixty per cent of the combined groups use a closed method; in the smaller group there is an even division.

A difference of opinion prevails as to which single factor is chiefly responsible for reasonably safe accomplishment of resection and immediate anastomosis, but most of the surgeons who made special comment on the subject considered the following to be contributory: (1) The advent of chemotherapeutic agents for oral use during the preoperative period; (2) a better understanding and utilization of preoperative preparation, especially as regards anemia and serum protein deficiency; and (3) improvement in anesthetic methods. In addition to these influences, a number of surgeons, especially Stone,[9] believes that a closed type of anastomosis contributes materially to the success of this undertaking. Somewhat more controversial are values placed on antecedent or concomittant use of decompressive measures.

In 1942 Stone, in a valuable contribution to the subject in which McLanahan collaborated, gave considerable impetus to the developing trend toward resection and immediate anastomosis of the colon. More recently technical methods and reasons for preference of primary anastomosis over extraperitoneal resection have been reported by White and Amendola,[10] Whipple,[11] Waugh and Custer,[12] Clute and Kenney,[13] Myer, et al,[14] Hoxworth,[15] Wangensteen,[8] MacFee,[16] and Ravdin.[17]

T. E. Jones,[18] Rankin,[19] Lahey, [20, 21] and David[22] have repeatedly urged that the old-type Mikulicz operation not be confused with the newer concept of extraperitoneal resection, exemplified by the obstructive resection of Rankin. They believe that in many, if not in most instances, an exteriorization measure, rather than primary suture of the bowel, is the proper choice:

TABLE I.—*Resection and Immediate Anastomosis of the Distal Colon*

	Incidence of Performance			Method of Anastomosis		
	5–24%	25–74%	75–100%	Closed	Open	Both
Group I..... (40 Surgeons)	2(5%)	11(27%)	27(67%)	25(62%)	11(27%)	4(10%)
Group II..... (10 Surgeons)	6(60%)	0	4(40%)	5(50%)	5(50%)	0
Total.....	8(16%)	11(22%)	31(62%)	30(60%)	16(32%)	4(8%)

that ample statistical data on resectability, mortality and five-year survivals attest the adequacy of this mode of resection, by which as great an extent of colon and gland-bearing mesentery can be removed as in resection and imme-

diate anastomosis. Jones still employs obstructive resection altogether for lesions of the distal colon, David in all but 5 to 10 per cent of cases, and, Lahey, and Cattell in all but 10 per cent of such lesions.

MacFee,[16] long an advocate of primary anastomosis as the procedure of choice, recently aptly expressed the concern with which a number of us have viewed the all-or-none attitude adopted by many surgeons in regard to primary suture of the distal colon after resection. It reads: "When primary resection is intended and an unforseen complication is encountered, there is always the inclination to proceed with the definitive operation as planned, bearing in mind, but at the same time disregarding, the fact that conditions for the operation are not ideal. The results may be chastening to the surgeon, and irreparably bad for the patient. It is the middle ground cases that offer the greatest temptation and, therefore, the greatest danger." Acually, McFee has been able to accomplish primary anastomosis after resection in not more than 25 per cent of his cases.

Controversy continues concerning the relative merits of the closed and open methods of intestinal anastomosis. Despite strenuous criticism by Whipple,[11] Meyers,[14] and others, of the aseptic technics, particularly those that employ special clamps, their popularity has grown steadily since 1937, when a survey made by us revealed almost universal preference for the open anastomosis. Stone, Rankin, Wangensteen, Waugh, White, Pemberton and Dixon are among those who believe mortality is favorably influenced by the closed technic. Coller,[23] who says that the aseptic method of anastomosis has become increasingly popular with their surgeons, believes that the striking point of difference between the two methods is not that peritonitis is more apt to occur with the one or the other, but that with any open anastomosis there is a high risk of contamination of the abdominal wall which withstands infection less well than the peritoneum.

DO YOU ROUTINELY ESTABLISH COMPLEMENTARY PROXIMAL DRAINAGE?

Results of this phase of the survey are shown in Table II. Fifteen, notably Ravdin,[17] Dioxn,[24] R. Graham,[25] Whtie,[10] Whipple,[11, 26] and Fallis,[27] regularly establish complementary drainage by means of cecostomy, transverse colostomy or appendicostomy; seven preliminary to resection and anastomosis and the remainder at the time of operation. Tube cecostomy is favored over other methods. Only three expressed preference for the Devine type of colostomy. A number of those who commented on this procedure consider it unnecessarily complicated and are in agreement with Dennis,[28] Fallis,[27] and Wangensteen,[29] who believe satisfactory defunctionalization and decompression can be attained by a simple loop colostomy. Stone,[9] Waugh,[12], Meyer, et al,[14] and Wangensteen[8] have recently taken positive stands to the effect that proximal drainage is not essential to a low mortality in primary suture of the left colon. Ravdin[17] considers decompression with the Miller-Abbott tube before, during and after resection to be an important contribu-

TABLE II.—*Complementary Drainage in Resection of the Left Colon*
(50 Surgeons—Group I, 40; Group II, 10)

Routine Employment of Surgical Decompression	
Group I	11 (27.5%)
Group II	4 (40.0%)
Both	15 (30.0%)
Preliminary to Resection	
Group I	5
Group II	2
Both	7 (47.0% of 15)
At Time of Resection	
Group I	6
Group II	2
Both	8 (53.0% of 15)
Types of Decompression	
Cecostomy	6
Transverse Colostomy	4
Cecostomy or Colostomy	4
Appendicostomy	1
Miller-Abbott Tube	5
Wangensteen Suction	17

tory factor in the reduction of mortality in primary resection. Although the tube did not always go through the ileocecal valve, Ravdin found it frequently did and thus obviated the necessity of a proximal drainage operation in many lesions of the distal segments of the colon. Only four other surgeons indicated that they made regular use of long tube decompression. Seventeen find decompression by means of an indwelling duodenal tube adequate in most instances.

DO YOU ROUTINELY EMPLOY CHEMOTHERAPY? PRELIMINARY TO, OR AT THE TIME OF OPERATION? IN WHAT FORM?

The answers to these questions are recorded in Tables III and IV. Forty-two, or 84 per cent, indicated regular use of chemotherapeutic agents. The small minority is equally divided between the two groups, constituting 10 per cent of the larger and 40 per cent of the smaller group. Twenty-seven limited use of the sulfonamides to the preoperative oral administration of sulfasuxidine or sulfathalidine. Fifteen, at the time of operation also instilled sulfanilamide or sulfathiazole into the peritoneal cavity. All but one of these are of the larger group. Penicillin is utilized postoperatively for periods of from three to ten days by 22. Only five regularly employ oral streptomycin preoperatively. Four others give sulfadiazine, orally or intravenously, as the drug of choice.

It is difficult to evaluate the favorable influence of any one therapeutic agent. This is particularly true of the sulfonamides and antibiotics for there have been no large series of cases reported in which adequate controls, run concurrently, have been provided.

Stone, Lahey, Cattell, Jones, Wangensteen and Gurd either use chemotherapy rarely or not at all. Allen[30] expressed the conviction of a number

TABLE III.—*Chemotherapy in Surgery of the Large Intestine*
(50 Surgeons—Group I, 40; Group II, 10)

Routine Use of Chemotherapeutic Agents	
Group I	36 (90.0%)
Group II	6 (60.0%)
Both	42 (84.0% of 50)
Preoperatively, Only	
Group I	22 (61.0%)
Group II	5 (83.0%)
Both	27 (64.0% of 42)
Preoperatively and at Operation*	
Group I	14 (39.0%)
Group II	1 (17.0%)
Both	15 (36.0% of 42)

*Sulfanilamide, 14; sulfathiazole, 1

TABLE IV.—*Chemotherapy in Surgery of the Large Intestine*
Types of Agents Employed

Preoperatively (Orally)	
Sulfasuxidine or thalidine	33
Sulfadiazine	4
Steptomycin	5
	42 (84% of 50)
At Operation (Intraperitoneally)	
Sulfanilamide	14
Sulfathiazole	1
	15 (36% of 42)
Postoperatively	
Penicillin	22
Streptomycin I.M.	1
Sulfadiazine I.V.	4
Sulfathaladine, orally	(5)*
	27 (64% of 42)

*Also uses penicillin

who have communicated with us when he said, "The added benefits of chemotherapy have doubtless played a role, but we believe too much credit has gone in this direction. Carefully controlled anesthesia, blood replacement, and better technical surgery, have really been the chief reasons for better results in our opinion." Pemberton,[31] on the other hand, feels that changes which have occurred in surgery of the colon since the introduction of chemotherapy have been "as spectacular and revolutionary as the changes wrought by iodine therapy in surgery of exophthalmic goiter." Other than use of chemotherapy, he stated, there had not been any major change in the management of colonic and rectal carcinoma at the Mayo Clinic during the past ten years, yet the over-all mortality rate progressively decreased after the routine employment of chemotherapy was instituted.

Ravdin,[17] et al, recently said that since the action of oral sulfonamides on intestinal bacteria is highly selective, the usual or even larger, doses are

occasionally without marked effect. Streptomycin, on the other hand, was found to be effective in part, at least, against all common intestinal pathogens. They noted that when given by mouth in a dosage of 0.25 Gm. every six hours the feces are free of streptococcus fecalis in eight days, and there results a marked reduction in the coloform group and anaerobic organisms of the Welchii type. They are now studying the effect of 5.0 Gm. daily to determine whether bacterial control is achieved in a shorter period of time.

It is apparently not generally known, as Poth,[32] et al, have demonstrated, that sulfathalidine and penicillin are antagonists. Sulfasuxidine must be used if penicillin is to be administered simultaneously. Yet, five with whom we corresponded said they administered postoperatively both sulfathalidine and penicillin.

DO YOU ROUTINELY PRACTICE ANTERIOR RESECTION OF THE RECTOSIGMOID WITH IMMEDIATE RESTORATION OF CONTINUITY? OR ONLY IN HIGHLY SELECTED CASES?

Only nine, or 18 per cent, of the 50 surgeons in this survey indicated that they regularly undertake this procedure for operable growths (Table V). Seven of these are in the larger group. Twelve, or 24 per cent of the total, signified that they never perform this operation, whereas 14 of the remaining 29 especially commented that they consider it justifiable only as a palliative measure when liver metastasis existed. Of the remaining 15 who indicated use of this method in highly selected cases, half further qualified their answer by appending such terms as, "rarely ever," "very seldom," or "rare," underscored. As evidence of a trend away from anterior resection are statements volunteered by eight to the effect that formerly they favored this measure as the operation of choice in all cases, but now use it only as an expedient or not at all. White[33] and several others in this group give credit for their decision to the recent (1947) report of Gilchrist and David[34] on their pathologic studies of lymphatic spread in cancer of the rectum. The objection to anterior resection most frequently expressed is the high incidence of local recurrence. Others were influenced by a high morbidity resulting from leakage at the suture line, with subsequent pelvic infection, fistula formation or occurrence of stricture at the site of anastomosis.

The principal advocates of anterior resection of the rectosigmoid are Dixon,[24] Wangensteen,[8] and Mahorner.[35] Their thesis is simply this: (1) carcinoma of the rectosigmoid does not ordinarily metastasize downward; (2) contrary to longstanding belief, the superior hemorrhoidal vessels may be sacrificed without impairment of the circulation of the divided ends of sigmoid and rectum; and, (3) avoidance of colostomy is a pre-eminently humanitarian consideration. Even were it assumed that there is a greater chance of recurrence with this type of operation, Mahorner[35] feels that "it may be justified on the grounds that many patients who are saved with colostomies are broken in spirit and morale to such an extent that in reality they would

TABLE V.—*Anterior Resection of Rectosigmoid*

Routine Employment	
Group I	7 (17.5%)
Group II	2 (20.0%)
Both	9 (18.0% of 50)
Rare Employment	
Group I	25 (62.5%)
Group II	4 (40.0%)
Both	29 (58.0% of 50)*
No Employment	
Group I	8 (20.0%)
Group II	4 (40.0%)
Both	12 (24.0% of 50)

*Use limited to inoperable cases by 14

be more fortunate to have been lost at the time of their operation. Forty people saved with a sphincter may be worth 50 people saved with permanent colostomy."

To date, the number of cases undertaken by this method has been too small in any one series, and the length of time which has elapsed since they were undertaken has been too short, to permit its proper evaluation. Waugh,[12] Wangensteen,[8] and Mahorner[35] have extended the scope of anterior resection to include ampullary lesions, which will be discussed subsequently.

DO YOU CONSIDER THE COMBINED ABDOMINOPERINEAL RESECTION THE OPERATION OF CHOICE FOR CANCER OF THE RECTUM AND RECTOSIGMOID? OR FOR THE RECTUM ONLY? OR DO YOU CONSIDER THE OPERATION OF CHOICE TO BE THAT ADVOCATED BY BACON IN WHICH COLOSTOMY IS ELIMINATED?

Forty-one, or 82 per cent, indicated the Miles operation as the procedure of choice both for lesions of the rectum and the rectosigmoid. The remaining nine qualified their answers with supplemental statements. Two of these employ the Miles operation for all rectal lesions, reserving anterior resection for those of the rectosigmoid. Seven routinely perform anterior resection not only for lesions of the rectosigmoid, but also for lesions at varying levels of the rectum as follows: three for all lesions more than 10 cm. above the pectinate line (one employs a pull-through operation for small, early growths); two for all lesions more than 5 cm. above this line; one for selected, small growths more than 6 cm. above the anus; and, one for all lesions at least 3 cm. above the ano-rectal line. (Table VI). All employ the Miles operation when cancers are situated below the levels which have been indicated. Nine who had in recent years performed an occasional operation of the Bacon type expressed dissatisfaction with the procedure and a disinclination to employ it in the future. No one indicated proctosigmoidectomy as the procedure of choice.

Waugh[36] supplemented his answers to these questions with the observation that he had used the pull-through operation of Babcock and Bacon in over 100 patients whose lesions were between 5 and 10 cm. from the pectinate

TABLE VI.—*Choice of Procedure in Cancer of the Rectum and Rectosigmoid*

Miles Operation	
Group I	33 (82.5%)
Group II	8 (80.0%)
Both	41* (82.0% of 50)
Anterior Resection	
Group I	6 (15.0%)
Group II	1 (10.0%)
Both	7* (14.0% of 50)
Proctosigmoidectomy (Bacon)	0

*Two others employ Miles operation for all but rectosigmoidal lesions.
*For lesions 10 cm. above anus (3); 5 cm. above (2); 6 cm. above (1); 3 cm. above (1).

line with a mortality of less than 1 per cent. Although he believes that if used advisably, this procedure is as curative as the Miles operation, he nevertheless found anal function to be not as good as it is following anterior resection and for this reason has extended downward the scope of the end-to-end anastomosis to include growths 5 cm. above the anus. For lesions below this level Waugh prefers the Miles operation. Wangensteen[37] in his additional remarks said that he reserved the abdominoperineal procedure for large, fixed ampullary growths and for all growths lying within 6 cm. of the anus. He further commented that the Babcock-Bacon type of operation, which he had performed on a number of occasions in recent years "fails to preserve the internal sphincter and in consequence fails to preserve continence." Also recently, in remarking on Babcock and Bacon's assertion that sphincterless perineal colostomy is to be preferred to abdominal colostomy, he said: "Whereas for sentimental reasons, the perineum may appear to be a more desirable location for an artificial anus, it would seem better to have such an opening where it may come more directly under the watchful eye of its owner."

Daniel,[38] who indicated that he considers the Miles operation the method of choice for all rectal lesions, provided unpublished statistics of his recent personal experiences with 20 anterior resections of the rectal ampulla in which primary anastomosis was done, 24 resections of the Babcock-Bacon type, and 34 abdominoperineal resections, all performed between December 1, 1945 and February 1, 1947. The incidences of secondary metastasis, or re-appearance at the operative site, were: (1) for anterior resection, 15 per cent; (2) for the Babcock-Bacon procedure, 30.38 per cent; and, (3) for the Miles operation, 1 wound metastasis, or 3.4 per cent. In a previous study[39] there were 22 wound mestases in 257 cases of abdominoperineal resection and colostomy and perineal resection, or an incidence of 7.7 per cent. Recurrences in the anterior resection were all in the bowel itself. Of the seven secondary metastases in the pull-through operations, in three instances perirectal nodes and fat were involved and in four there was no discernable involvement outside the bowel wall.

Of those who utilize anterior resection or the pull-through operation for rectal growths, only a few, notably Babcock, Bacon, and Garlock, include lesions situated as low as 3 cm. from the ano-rectal line. Wangensteen[8] is convinced, despite the failure of Coller and his associates to find evidence of lateral lymphatic spread in lesions lying more than 3 cm. above the anus, that in low-lying lesions, failure to excise the levator muscles in juxtaposition to the bowel invites local recurrence. "I have learned," he states, "the bitter lesson that it is unwise to attempt to salvage sphincters in such low-lying lesions. If one does so, he compromises on the cure."[40]

It is interesting to observe that the proponents of the two conflicting schools of thought in the treatment of cancer of the rectum both find inspiration and guidance in the several pathologic studies of lymphatic spread in rectal cancer. The most enthusiastic champions of preservation of the anal sphincteric mechanism, Babcock, Bacon,[42] Lynch,[1] Waugh,[12] and Wangensteen,[8] have all pointed to the common finding of these investigations namely, infrequent retrograde or downward spread of rectal cancer as justification for operative methods which eliminate colostomy. On the other hand, the staunchest supporters of the principles of Miles include four surgeons—Gabriel,[4] Coller,[6] Gilchrist[5, 34] and David[5, 34]—who have played important roles in demonstrating the pattern of lymphatic metastasis in cancer of the rectum. The latter two, as a result of their most recent (1947) study, concluded that "Lesions which are partially or completely below the peritoneal reflection have a high incidence of local and liver recurrences and pull-through or sleeve resections are not much better than a local resection. The Miles operation seems to give the best chance of cure here." Rankin,[43, 44] Jones,[45] Lahey, Stone, and many others have referred to these pathologic studies as additional proof of the necessity for the radical rather than the conservative resection of the rectum. Jones[45] found that the relatively high incidence of local recurrence in the cases recently reported by Gilchrist and David "proves further that radicalism is necessary and that revival of the pull-through operations and low anastomosis will be short-lived." Along these same lines Rankin[44] said that "Since Miles' epic publication there have been innumerable surgeons, goth great and small, who have tried to develop many procedures for the preservation of the anal sphincter in the treatment of cancer of the rectum. In the light of the recent anatomic studies of the lymphatics of the perirectal and pelvic tissues carried on by David and Gilchrist and again by Coller, et al, there seems little justification for their efforts."

SUMMARY AND CONCLUSIONS

1. A survey by questionnaire was undertaken to determine current trends in the surgical treatment of cancer of the distal colon and rectum as practiced by 50 surgeons with relatively large experience in this field. The opinions of 10 of these whose pre-eminence few would question have been contrasted with those of the remainder of the group. Identical opinions of approximately 20

qualified colleagues of these 50 are not included in this survey. The departments of surgery of 31 medical schools and seven clinics are represented.

2. There was noted a decided trend away from extraperitoneal, multistage operations for lesions of the distal colon. Sixty-two per cent of the combined groups estimate employment of primary anastomosis in 75 to 100 per cent of cases. In the smaller group 60 per cent believe they use this method in fewer than 25 per cent of instances; the remaining four estimate a performance of over 90 per cent.

3. Sixty per cent of the combined groups use a closed method of anastomosis; in the smaller group there is an even division between this and the open technic.

4. Fifteen, or 30 per cent, routinely establish complementary proximal drainage by means of appendicostomy, cecostomy, or transverse colostomy: seven preliminary to resection and anastomosis and the remainder at the time of operation. Three expressed preference for the Devine type of colostomy. Seventeen find decompression by means of an indwelling duodenal tube adequate in most instances. Five regularly utilize decompression by the Miller-Abbott tube before, during and after resections of lesions in the distal colon.

5. Forty-two, or 84 per cent, indicated regular use of chemotherapeutic agents. The small minority is equally divided between the two groups, constituting 10 per cent of the larger group and 40 per cent of the smaller one. Twenty-seven limited the use of sulfonamides to the preoperative administration of sulfasuxidine or sulfathaladine. Fifteen, or 36 per cent, of the 42 who regularly utilized chemotherapy also instill either sulfanilamide or sulfathiazole into the peritoneal cavity at the time of the operation. All but one of these are of the larger group. Five regularly administer oral streptomycin preoperatively. Twenty-two use penicillin postoperatively.

6. Only nine, or 18 per cent, regularly perform anterior resection of the rectosigmoid for operable lesions. Seven of these are in the larger group. Twelve, or 24 per cent, never undertake this procedure, whereas 14 of the remaining 29 consider it justifiable only as a palliative measure when liver metastasis exists. Of the residual 15 who indicated use of the method in highly selected cases, half further emphasized infrequency of employment by appending such terms as, "rarely ever" or "very seldom." Eight commented on their former routine use of anterior resection which they no longer consider a proper procedure.

7. Forty-one, or 82 per cent, indicate the Miles operation as the procedure of choice both for lesions of the rectum and rectosigmoid. Two of the remaining surgeons elect the Miles operation for all lesions except those involving the rectosigmoid, for which they prefer anterior resection. Seven regularly practice anterior resection for all rectosigmoidal growths and for rectal growths located as follows: three for lesions which are at least 10 cm. above the ano-rectal line (one occasionally uses a pull-through operation for

small, early growths); two for those 6 cm. above this line; and one each for lesions situated respectively 5 and 3 cm. above the anus. Nine who had in recent years performed operations of the Babcock-Bacon type expressed dissatisfaction with the procedure and a disinclination to employ it in the future. No one indicated proctosigmoidectomy as the operation of choice.

8. From the foregoing expressions of opinion by those in this country who probably undertake most of the surgery of the large bowel for cancer, it would seem that one may properly conclude that there no longer exists cause for the concern felt by many of us, and expressed before this Association last year by Allen,[30] over what appeared to be a widespread revival of interest in operations upon the rectum that include preservation of the anal sphincter. It would now appear that a transient trend in that direction has, as Jones[45] recently predicted, the probability of being short-lived. One trend, however, will in all likelihood end in universal acceptance in suitable cases. Reference is made to the steadily growing tendency to perform single-stage rather than multi-stage operations for lesions in every segment of the large intestine. This is accomplished for the transverse, descending and sigmoid portions of the colon by immediate anastomosis after resection and for the rectosigmoid and rectum by a one-stage combined abdominoperineal resection.

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FAMILIAL POLYPOSIS AND CARCINOMA OF THE COLON*

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POLYPS OR POLYPOSIS OF the large intestine and their relationship to the etiology of cancer have for many years been the subject of study by those interested in colon surgery. Most observers have accepted Erdmann and Morris'[10] division of polyps of the colon into two distinct groups:

1. Single or multiple polyps developing largely in adults as *simple* neoplasms of the mucosa (Adenomata), or *secondary* to or in association with acute or chronic inflammatory disease such as ulcerative colitis.
2. Diffuse multiple polyposis (polyposis intestini) found in childhood, adolescence or early adult life, where often the entire colon and rectum will be diffusely involved, with marked hereditary and familial background as a basis for its occurrence and a great likelihood for carcinoma developing at an early stage.

While diffuse familial polyposis has been regarded as relatively rare in occurrence, Scarborough[18] was able to collect 301 cases reported in the literature up to 1937, and McLaughlin[27] 331 up to 1943. Since then 24 more cases have been placed on record. (McLaughlin,[27] Pugh and Nesselrod,[32] Hickman,[31], Pfeiffer and Patterson,[33] Rachet, Busson, Galmiche and Rosey,[25] Laveuf, Laurence and Poneche,[30] and Guptill[34]).

In 1930 Dukes[13] was able to collect 14 reports in which one or more families with hereditary multiple polyposis had been recorded and since then 22 more have been added to the record. Guptill[34] reviewed 58 cases treated by surgery up to 1947. The number of these reports indicates that familial colon polyposis while formerly considered rare actually cannot be too uncommon.

A recent extraordinary experience with a family in which a very high incidence of diffuse polyposis of the colon and subsequent cancer was found, is the basis of this report.

Case 1.—Male—25 years of age, single, was my first contact with this family. In November, 1942, three months before examination, while in U. S. Army service, he began to have pain in rectum after defecation and bloody, frequent stools. He was unrelieved by medical measures and was discharged from the army and returned home for surgical treatment. His family history was negative except that his mother had died of carcinoma of the sigmoid at 41 years. There had been no loss of weight. His physical examination was essentially negative except for the rectum. Rectal examination revealed an ulcerating mass 3 cm. in diameter on the anterior wall just within the anal sphincter. Proctoscopic examination, besides the ulcerating mass, showed numerous bleeding polyps of the rectum and sigmoid. Adenocarcinoma Grade II was reported from the biopsy taken from the ulcer.

On November 11, 1942 abdomino-perineal resection of rectum and sigmoid was done. 37 cm. of gut removed. The entire rectum and sigmoid were densely studded with polyps 1 to 6 mm. in diameter. The ulcerating mass on the anterior rectal wall close to

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the sphincter was polypoid—measured 4 cm. in diameter. Microscopic examination showed Adenocarcinoma Grade II (Fig. 1). The regional lymph nodes were found negative for evidence of malignancy.

He made an uneventful recovery except for a perineal abscess that required draining 9 mos. and again 14 mos. after operation. Subsequent roentgenogram of remaining colon showed diffuse polyposis of transverse and descending colons but he rapidly gained 35 pounds in weight, was married and refused all further surgery (Fig. 2).

Five-year follow-up examination: The end colostomy is functioning well. He has occasional mild bloody diarrhea, but normally two stools a day. Perineal wound well healed. No evidence of local recurrence. Definitely overweight—205 pounds. He will eventually require total colectomy and permanent ileostomy. No evidence of abdominal mass or intestinal obstruction to date.

Case 2.—Fifteen months after treating Case No. 1, his brother, 29 years of age, appeared for treatment. He was married and had two children 5 and 3 years of age. One year before he had been hospitalized for three months for treatment of a compound

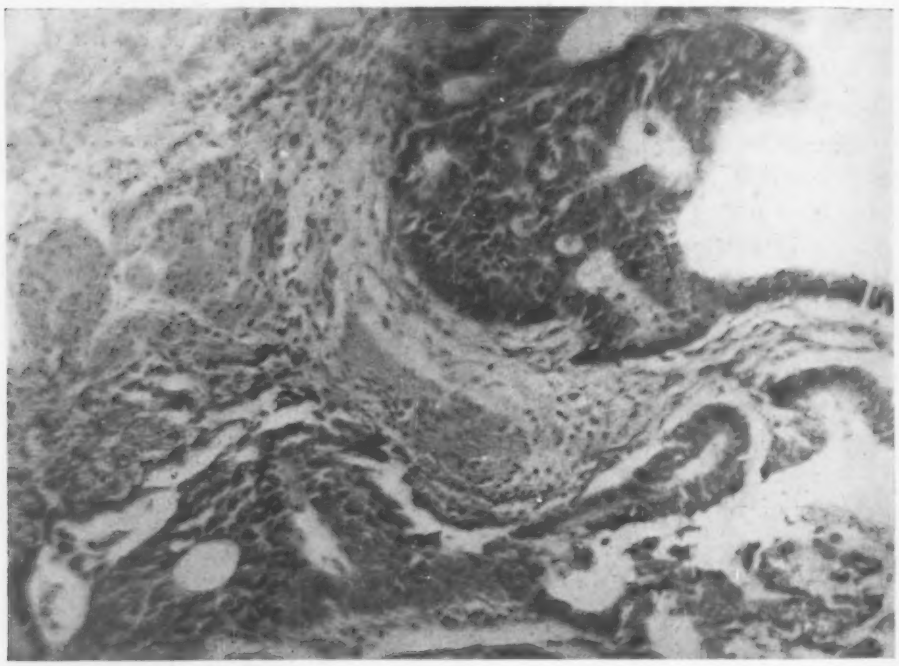

FIG. 1.—Case 1: Adenocarcinoma of rectum superimposed on multiple polyposis.

fracture of the tibia. He recovered function of his leg slowly. For six months he had had occasional diarrhea, anorexia, easy fatigue, and had lost 45 pounds in weight. Eight years before he had been treated elsewhere for multiple rectal and sigmoidal polyps, with removal of one large benign rectal polyp. On physical examination he showed marked emaciation, a large nodular liver and a mass in the upper left abdomen indistinctly outlined. Rectal examination was negative.

Exploratory laparotomy February 7, 1944 revealed a huge carcinoma of the sigmoid, involving 10 to 12 cm., but no apparent obstruction to the lumen of the gut, many enlarged retro-peritoneal glands, massive metastases to the liver. The huge right lobe of the liver formed the mass in the upper left abdomen. A nodule removed for

biopsy showed Adenocarcinome Grade II. He recovered uneventfully from the exploration but died at home on April 28, 1944. No autopsy was obtained.

Since two members of this family had developed carcinoma superimposed upon multiple polyposis of the rectum and sigmoid and since the mother had died of cancer of the sigmoid, and a sister had died elsewhere apparently from advanced carcinoma of the sigmoid, a thorough investigation and complete health record of the remaining members of the family, with details of the

FIG. 2.—Case 1: Multiple polyposis of transverse and descending colons.

final illnesses of the mother and daughter who had died, seemed definitely indicated.

This was a family of Italian extraction, consisting of a man and his wife and seven children, one of whom died in infancy. The histories of the second and fourth children have been recorded above. The health record of the remain-

ing members of the family are as follows:

FATHER: No family history of cancer.

Details of health of relatives unknown—living in Italy.

For years he had been overweight. Had had a thyroidectomy for toxic adenoma. Hypertension.

(Died later at 68 years of age of cerebral hemorrhage.)

MOTHER: *Family History*—Father died at 40 years, cause unknown. Carcinoma?

Mother, three brothers and one sister living and well.

One brother died in infancy.

At 37 years of age (1928) developed an acute intestinal obstruction. Following an emergency colostomy for its relief, an anterior resection of the sigmoid was done for a constricting adenocarcinoma. The restricted specimen showed a benign

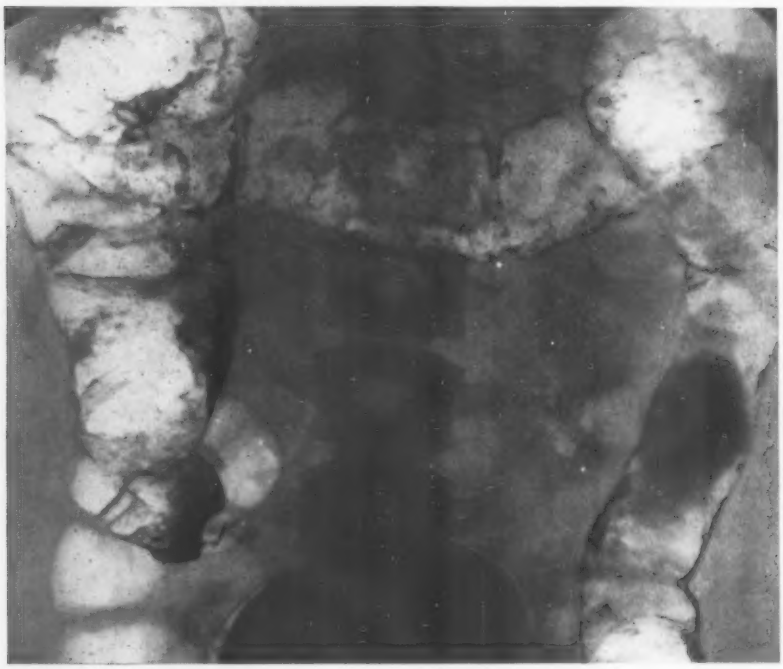

FIG. 3.—Case 6: Multiple polyposis of ascending, transverse and descending colons.

polyp proximal to the growth and at operation polyps were palpated in the descending colon. Died at 41 years, 3½ years after operation, from general peritoneal carcinomastosis—proven at autopsy. (Information obtained through the courtesy of Dr. D. K. Santee, Bethlehem).

CHILDREN: *Child 3.* Female—24 years—single.

Following a six-months' history of intermittent abdominal pain—occasional diarrhea, fatigue, anorexia and loss of weight, exploratory laparotomy revealed an advanced carcinoma of the sigmoid with polyps in the sigmoid and descending colon and intraperitoneal metastases. She died three months later (1941). No autopsy. (Information obtained through the kindness of Dr. Leonardo, Rochester, New York).

The three remaining children were contacted and agreed to examination.

CHILD I: Female—35 years (1944)—2 children, 6 and 1 yr.

Free of all symptoms referable to disturbed bowel function. Normal bowel habit.
Routine Examination revealed:

1. Rectum and pelvis negative to palpation;
2. Proctoscopic examination—Negative for polyps or neoplasm up to mid-sigmoid.
3. Barium double contrast enema revealed diffuse polyposis of transverse and descending colons.

Colectomy advised, but operation refused because of lack of symptoms and family economic demands.

CHILD I: Three-year follow up—She is still without symptoms.

Check roentgenogram shows polyposis of sigmoid and descending colon. One polyp in sigmoid destroyed by fulguration. No evidence of malignancy. (Dr. Leonardo)

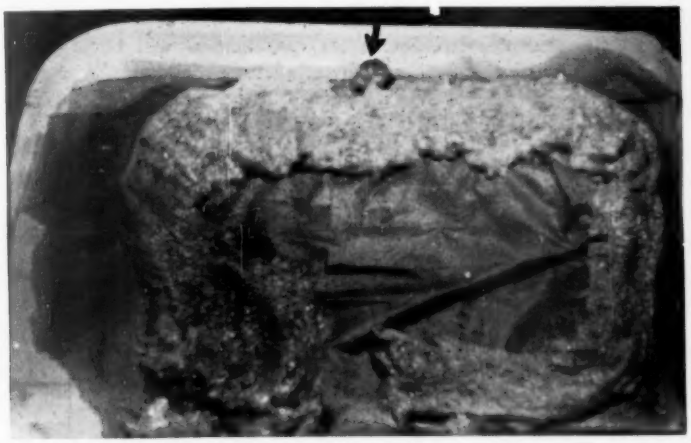

FIG. 4.—Case 6: Entire colon resected—studded with polyps—one very large polyp in transverse colon.

CHILD V: Male—29 years (1947)—unmarried.

Absolutely symptom free. Normal bowel movements.
Defecation three to four a day.
Routine Examination revealed:

1. Rectum examination showed one palpable polyp on the anterior wall.
2. Proctoscopic examination revealed numerous discrete sessile polyps, approximately 4 to 8 mm. in diameter, as far up as the middle of the sigmoid.
3. Barium double contrast enema—refused for the present.

Case 3.—CHILD VI: Female—23 years (1944). Unmarried. Symptom free. In good health. Proctoscopic examination revealed multiple polyps of rectum and sigmoid, discrete and not confluent.

Double contrast enema by roentgen showed multiple polyposis of ascending transverse and descending colons. (Fig. 3).

As the polyps in the rectum and sigmoid, though numerous, were discrete, local destruction by fulguration was advised to be followed by ileosigmoidostomy and total colectomy. Accordingly after the rectal and sigmoidal polyps were destroyed and the rectum and sigmoid had remained free of all evidence of recurrence for six weeks, on July 14, 1944 ileosigmoidostomy was done with further local removal of polyps in sigmoid at site of anastomosis. Many polyps in transverse and descend-

ing colon could be palpated. Following uneventful recovery from the above procedure on November 3, 1944—the ileum distal to the ileosigmoidostomy, the entire colon—cecum, ascending, transverse, descending colon and upper sigmoid were resected. The colon removed measured 65 cm. in length. The mucosa everywhere was studded with polyps—over 100 were counted. The largest was in the transverse colon—3 cm. in diameter and 2½ cm. long. (Fig. 4). Though this large polyp was definitely a pre-cancerous lesion, no evidence of malignancy could be detected.

Microscopic diagnosis—benign polyposis.

Three-year follow up.—She is in good health, has occasional abdominal pain—has required further fulguration for rectal and sigmoidal polyps. She now has 15—20 polyps, all discrete, in rectum and rectosigmoid. Visualization to mid-sigmoid anastomosis is easy. Further destruction by fulguration advised and re-examination in six months.

The children of the third generation are all at present symptom free and seem too young for satisfactory complete diagnostic survey. It has been recommended that if bowel symptoms or melena develop, immediate examination will be imperative and as they attain *12 or 13 years* of age (puberty) a complete study should be made.

While diffuse polyposis has been found at an early age, 2 years or even at birth (McKenney),[15] Kennedy[29] believes it is rare in children.

The history of this family may be summarized by the following diagram. (Fig. 5).

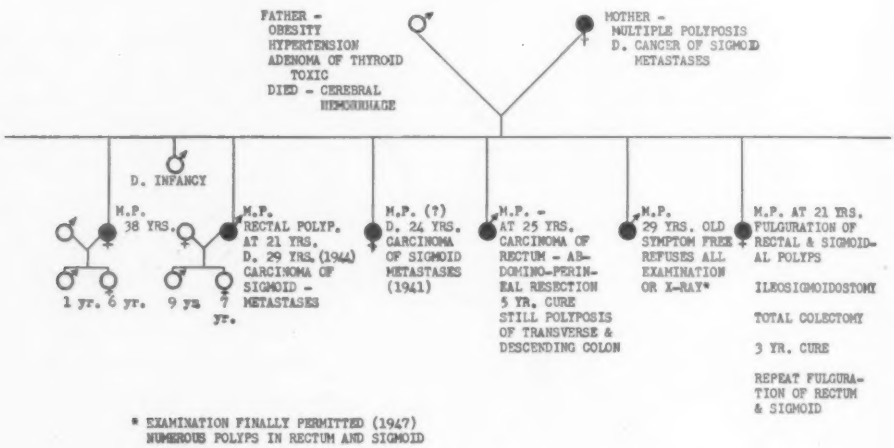
FATHER - OBESITY HYPERTENSION ADENOMA OF THYROID TOXIC DIED - CEREBRAL HEMORRHAGE
MOTHER - MULTIPLE POLYPOSIS D. CANCER OF SIGMOID METASTASES
D. INFANCY
M.P. 38 YRS.
1 yr. 6 yr.
9 yr.
7 yr.
M.P. RECTAL POLYP. AT 21 YRS. D. 29 YRS. (1944) CARCINOMA OF SIGMOID - METASTASES
M.P. (?) D. 24 YRS. CARCINOMA OF SIGMOID METASTASES (1941)
M.P. - AT 25 YRS. CARCINOMA OF RECTUM - ABDOMINO-PERINEAL RESECTION 5 YR. CURE STILL POLYPOSIS OF TRANSVERSE & DESCENDING COLON
M.P. 29 YRS. OLD SYMPTOM FREE REFUSES ALL EXAMINATION OR X-RAY*
M.P. AT 21 YRS. FULGURATION OF RECTAL & SIGMOIDAL POLYPS
ILEOSIGMOIDOSTOMY
TOTAL COLECTOMY
3 YR. CURE
REPEAT FULGURATION OF RECTUM & SIGMOID
* EXAMINATION FINALLY PERMITTED (1947) NUMEROUS POLYPS IN RECTUM AND SIGMOID

FIG. 5.—History of family summarized.

COMMENT

A woman, whose father probably died of carcinoma and who, at 37 years of age, had a carcinoma of the sigmoid with polyposis of sigmoid and descending colon, had seven children. One died in infancy. *Of the remaining six all have either died of carcinoma of the sigmoid with previous polyposis of the rectum and colon, or have been shown to have multiple polyposis of the colon and rectum with or without carcinoma.*

This extraordinary family history illustrates again the remarkable hereditary tendency of multiple diffuse colon polyposis to be transmitted to succeeding generations and the high incidence of cancer associated therewith, and

furthermore, demonstrates that both males and females may transmit and acquire the disease.

Likewise, the fact that in three of the family who were completely symptom free, thorough investigation revealed well established colon polyposis, indicates *the fallacy of reliance upon history or symptoms alone as indicative of the presence or absence of disease.* Individuals of these susceptible families can be considered *free* of the disease *only after complete diagnostic survey* fails to reveal any vestige of polyposis or cancer.

A single negative survey, even in an adult, is not sufficient indication that the individual will remain free of the disease. Lockhart-Mummery[20] cites the case of a man who at 39 years had a completely negative survey and who four years later was found to have advanced diffuse polyposis. Members of a polyposis family who are found by complete investigation to be apparently free of the disease, should have routine re-surveys every six months, or more often if bowel symptoms supervene, if they are to be adequately protected against the insidious, unheralded advent of multiple polyposis or a colon or rectal cancer.

DISCUSSION

While Scarborough refers to Menzel[1] as reporting the first case of diffuse polyposis in 1721, in modern literature Luschka,[2] as well as Lebert[3] gave accurate descriptions of the disease in 1861, followed by Virchow[4] in 1863, who detailed the first thorough pathological background of this lesion. A further report by Richet[5] in 1878 was followed by Cripps'[16] classical description of two cases in 1882 indicating the familial hereditary tendency of multiple polyposis. Smith's[3] cases in one family were recorded in 1887. Finally in 1890 Handford[8] called attention to the fact that *cancer* was frequently implanted upon familial diffuse polyposis. Cuthbert Dukes[13] was able to collect 14 reports in which families with hereditary tendency to multiple polyposis had been recorded. By 1947 at least 36 instances of families with hereditary tendency to multiple polyposis had been reported.[13 to 34]

Most observers agree that while multiple polyposis, or polyposis intestini as it is designated in continental literature, is not itself congenital; nevertheless, a *predisposition to tumor* formation in the colon and rectum *is inherited.* It must be likewise understood that any suspicious case in a suspected family even if found free of polyps is not necessarily free of the hereditary blemish. It is generally held the defect is inherited as a Mendelian Dominant, "A gene mutation"—an inherited instability of the epithelial cells of the large bowel which renders their nuclei peculiarly liable to undergo mutation for excessive rate of growth; i.e. "Mitotic Division is more frequent." (Luckhart-Mummery and Dukes).[20] It is transmitted by either sex and occurs in both male and female descendants.

However, Friedell and Wakefield[28] state that one-half of the cases of diffuse polyposis seen at the Mayo Clinic do not have an hereditary factor

and deny that multiple polyposis follows any genetic pattern. They believe it is neither a mendelian dominant nor a recessive.

True familial polyposis or polyposis intestini may be considered a distinct entity with two characteristic features:

1. It tends to develop in succeeding generations of the same family—familial predisposition.
2. It is a pre-cancerous lesion. Cancer frequently will eventually develop upon it. Members of families with multiple polyposis tend to die of cancer of the colon or rectum or its metastases. Incidence of carcinoma in multiple polyposis is variously given statistically as 34.6% (Hulsieck[11]), Wechselman 50% to 60% (Dukes[13]), Bargen and Coffey 82.8%.[19] However, untreated cases are all likely to develop cancer. *The potential incidence of cancer following multiple polyposis should be considered 100%.*

Age. Doehring[19] analyzed the age of 40 cases as:

Years	*Number of Cases*
1-10	2
10-20	10
20-30	10
30-40	13
40-50	2
50-60	2
60-70	1

In Lockhart, Mummery and Dukes'[30] families, the average age at which multiple polyposis was discovered was 22 years; youngest, 8 years; oldest, 43. The average age at which *multiple polyposis* was estimated to *begin* to develop was *20 years* and *malignant changes 15 years later* (35 years). Untreated cases of multiple polyposis die of cancer in their early 40's.

SYMPTOMS

Multiple polyposis of colon and rectum may be *symptomless for years.* Bloody diarrhea with occasional abdominal cramps, anorexia, and loss of weight have been commonly associated with an active or advanced lesion. In families in whom one or more have been known to have multiple colon polyposis, those without symptoms should never be considered *free of the disease unless repeated diagnostic survey is negative.*

DIAGNOSIS

The diagnosis can be made by three procedures:

1. Digital examination of rectum (rectal polyps).
2. Proctoscopic and sigmoidoscopic examination.
3. Roentgen-ray examination of colon by double contrast enemata. A simple contrast enema with barium is usually ineffective in demonstrating polyps. Colon dilatation with air following a barium enema

gives a double contrast medium that outlines most of the polyps very satisfactorily.

TREATMENT

The treatment of choice is total colectomy, the complete elimination of the colon and rectum as a possible origin of future cancer, usually in three stages:

1. Preliminary ileostomy.
2. Resection of entire colon and sigmoid.
3. Posterior resection of remaining rectum and rectosigmoid.

However, Rankin,[16], Jones,[21], Lockhart-Mummery,[30] and C. W. Mayo[14] have all advocated a compromise procedure to preserve the rectum and rectal sphincter in those cases in which the polyps in the rectum and lower sigmoid may be destroyed by fulguration through the sigmoidoscope; i.e.,

1. Fulguration of rectum and sigmoid.
2. Ileosigmoidostomy.
3. Resection of lower ileum and entire colon down to lower third of the sigmoid. Hemi-colectomy may be done at the same time as the ileosigmoidectomy (C. W. Mayo).[14]

Guptill[34] recently has recommended an end to end anastomosis of the ileum to the rectum, leaving a stump of rectum 8 cm. or less, which can be easily reached by the proctoscope for fulguration if rectal polyps recur. Guptill[34] bases this recommendation upon the need in two cases for resection of the remaining sigmoid stump for recurrent polyps—following typical ileosigmoidostomy. Pfeiffer and Patterson[33] likewise prefer an ileorectosigmoidostomy in order that the junction of the ileum with the sigmoid be sufficiently low.

A low union of ileum with rectum or rectosigmoid would seem highly desirable in view of the frequency with which further polypoid formation after simple fulguration is met. Certainly, if any suspicion of carcinomatous change in rectal polyposis is aroused, any idea of conservation of the rectum should be abandoned and total colectomy including the rectum should be done.

From time to time, radiation of colon polyposis has been suggested and attempted in a conservative approach to the solution of the polyposis problem but at best it has been found to be merely palliative. (Dukes,[13] Vanzant,[26], McKenney.[15]) McKenney[15] has reported continuing progress of tumor growth under even heavy radiation and as Guptill[34] well says, "Treatment by roentgen-ray would seem illogical because the well differentiated cells of the adenomas should be radiation resistant."

CONCLUSIONS

1. A family is reported in which the mother and all six adult children had either multiple polyposis of the colon or carcinoma of the sigmoid or rectum or both.

2. The mother at 41 years, one son at 29 years, and one daughter at 24

years, died of carcinoma of the sigmoid associated with polyposis of rectum and colon.

3. One son at 25 years had an abdomino-perineal resection for cancer of the rectum with multiple polyposis of rectum and sigmoid. He is now living and well five years after operation—with polypoid transverse and descending colons.

4. Two daughters and one son who were symptom free were found to have multiple colon polyposis, one of whom subsequently had a total colectomy with ileosigmoidostomy and fulguration of rectal and sigmoid polyps.

5. Multiple diffuse colon polyposis is a distinct entity characterized by
   1. Tendency to develop in succeeding generations of same family with high incidence of occurrence—familial predisposition. It occurs in both males and females and may be transmitted by both.
   2. Carcinoma frequently or eventually will develop upon it at a relatively early age.

6. It is often symptomless but may be diagnosed by
   1. Rectal examination.
   2. Sigmoidoscopic examination.
   3. Double contrast (barium-air) enema, roentgen-ray investigation.

7. All members of a family in whom diffuse colon polyposis is found, should be *investigated* thoroughly for evidence of the disease.

8. Treatment of choice is total colectomy with or without resection of rectum. In cases in which polyps of rectum and rectosigmoid may be destroyed by fulguration, the rectum may be saved and total colectomy with ileosigmoidostomy will suffice. If the rectum and rectosigmoid is saved, proctoscopic re-examination should be done at least every six months as recurrence or further development of rectal polyps can be anticipated. Prompt fulguration of all new polyps is imperative if development of cancer in the remaining rectum is to be prevented. If cancer in remaining rectum does develop, abdomino-perineal resection with permanent ileostomy will be required.

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LOW ANTERIOR SEGMENTAL RESECTION WITH OR WITHOUT COLOSTOMY*

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A MORE DESCRIPTIVE but longer title for this paper than the one we have used would be "A comparative study of low anterior segmental resection of the colon and upper portion of the rectum for malignant lesions with primary anastomosis between the sigmoid and rectum, with or without concomitant colostomy."

This subject is controversial and the controversy is concerned principally with two points: (1) whether anterior segmental resection and primary anastomosis with or without previous or concomitant colostomy should be performed for malignant lesions in the upper part of the rectum, rectosigmoid and lower part of the sigmoid, and (2) whether any method short of combined abdominoperineal resection or what other surgeons consider an equivalent of that operation is adequate.

At one time one of us (Mayo) would have agreed whole-heartedly with those who are of the opinion that the best operation in all instances of malignant lesions of the lower portion of the sigmoid, the rectosigmoid and upper portion of the rectum is a one-stage combined abdominoperineal resection. It now becomes expedient to qualify previous expressions of opinion since it appears that in many cases a radical procedure can be performed and primary anastomosis accomplished with low immediate risk, and also with a shorter period of morbidity, compared with that for the combined abdominoperineal resection. Furthermore it seems likely, that in those instances the end result of such a procedure may prove to be as satisfactory as that of the combined abdominoperineal resection.

In 1946, 266 cases in which nonpalliative, one-stage combined abdominoperineal resection had been performed three or more years previously on the service of one of us (Mayo), were reviewed and follow-up data were obtained. This study disclosed an over-all hospital mortality rate of 6.1 per cent; lymphatic involvement in 50 per cent of cases; a three-year survival rate of 86.3 per cent and a five-year survival rate of 72.5 per cent in cases in which nodes were not involved; and a three-year survival rate of 57.2 per cent and a five-year survival rate of 38 per cent in cases in which nodes were involved. In other words, of those patients considered at the time of operation to have

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a chance for cure, 72 per cent were alive three years and 56 per cent five years after operation.

On the basis of what is known about the infrequency of retrograde spread of carcinoma of the rectosigmoid and upper portion of the rectum and on the basis of technic employed for the abdominal resection of the mesentery, ligation of the inferior mesenteric vessels or superior hemorrhoidal artery, as well as for the perineal portion of the combined operation, an anterior segmental resection of the intestine seems feasible. It even can be employed in the majority of cases in which lymphatic involvement exists. If it is properly performed, and if adequate resection is possible, it is comparable in radicalness to the combined abdominoperineal resection.

TABLE I.—*Situation of Lesion*

Situation above anus	Anterior segmental resection	
	With colostomy	Without colostomy
5 to 10 cm.	32	29
11 to 15 cm.	68	71

TABLE II.—*Anterior Segmental Resection*

	Lymphatic involvement	No lymphatic involvement
With colostomy	50*	50*
Without colostomy	43	57
Total	93	107

*Same proportion as that found in a review made by one of us (Mayo) of cases in which combined abdominal-phineal resection was performed.

The terms, "properly performed" resection and "adequate" resection, mean a resection carried out as high on the sigmoid colon as it would be carried out in a "properly performed" combined abdominoperineal resection. It also is of vital importance that an anastomosis anywhere in the gastro-intestinal tract should not be under tension. Therefore, if, because of a short mesosigmoid or a short sigmoid loop, the bowel cannot be resected at a satisfactory distance above the growth, a combined abdominoperineal resection is then the operation of choice.

Other contraindications to an anterior segmental resection are fixed growths, perforation and an undue amount of inflammatory reaction about the lesion; growths that are less than 6 cm. above the dentate margin of the anus in most instances, and those that are 6 cm. above the dentate margin in many instances. For growths situated less than 6 cm. from the dentate margin, it is our opinion that the optimal results will be obtained in the majority of cases by a combined abdominoperineal resection in one stage.

A considerable amount of careful work has been done on retrograde spread of carcinoma of the rectum and rectosigmoid by many men, including Dukes; Coller, Kay and MacIntyre; Gilchrist and David; and Glover and Waugh. The various studies indicate the relative safety with which anterior segmental resection can be performed from the standpoint of malignant spread, at least in the upper third of the rectum and in the rectosigmoid, provided the dissection and resection are carried out at points at least 2 to 2.5 cm. below and above the growth, as is done when combined abdominoperineal resection is performed. In only 1 per cent of the cases of far-advanced carcinoma does retrograde spread exist to any degree.

Metastasis to the liver, within limits which must be left to surgical judgment, is not per se a contraindication to low anterior segmental resection. Many palliative resections of this type have been performed but operations for this purpose do not come within the scope of this paper.

TABLE III.—*Anterior Segmental Resection with Colostomy*

Type	Grade				Total cases
	1	2	3	4	
A	2	2	0	0	4
B	25	16	5	0	46
C	10	37	3	0	50
Total	37	55	8	0	100

TABLE IV.—*Anterior Segmental Resection without Colostomy*

Type	Grade				Total cases
	1	2	3	4	
A	7	0	0	0	7
B	27	18	4	1	50
C	6	33	2	2	43
Total	40	51	6	3	100

MATERIAL STUDIED

In order to be as fair as possible in this study, two series of 100 consecutive cases each were studied. In each case the carcinoma was situated from 5 to 15 cm. above the anus, as determined by proctoscopic examination. In one series, the anterior segmental resection and primary anastomosis was accompanied by a colostomy (usually in the transverse colon), and in the other series the same operation was performed without colostomy.

In so far as could be determined, in each series the resection of the intestine above the growth was as extensive as that accomplished by the usual type of combined abdominoperineal operation with ligation of the inferior mesenteric vessel and removal of that portion of the intestine containing the superior hemorrhoidal vessels. Also an effort was made to resect the bowel at a point at least 2 cm. below the growth. If this could not be accomplished without tension on the anastomosis neither type of operative procedure was

considered suitable. In other words, with the exception of an accompanying colostomy in one series, other considerations were comparable in all cases, within justifiable limits.

Comparison of methods of surgical technic used in dealing with any pathologic lesion in any location is subject to criticism. It might be inferred that in those cases in which colostomy was performed concomitant with anterior resection, it was because of the degree of obstruction caused by the lesion, but this was only rarely the case. Usually when colostomy was performed the surgeon preferred this surgical method; the consideration usually was that of defunctionalizing the lower segment of the bowel. In dealing with this type of case, one of the authors (Mayo) has preferred and employed the one-stage segmental resection without colostomy in all cases in which it has been feasible for the past two years.

Since each series is small and the operations have been performed so recently that three-year and five-year survival rates cannot be determined, the long-time prognosis will not be considered in this paper. It is reasonable to suppose, however, that in these locations adequate segmental resection and combined abdominoperineal resection carry essentially the same prognosis.

AGE AND SEX

As might be expected, the majority of patients were in the fifth, sixth and seventh decades. The youngest of the 200 patients was 19 years and the oldest was 76 years of age.

There was an even distribution of 101 male and 99 female patients. A fairly equal division was found in each series.

SITUATION AND TYPE OF OPERATION

The situation of the lesion and the type of operation performed are shown in Table I and an analysis of cases from the standpoint of involvement of lymph nodes is shown in Table II.

GRADE AND CLASSIFICATION OF GROWTHS

It will be noted from tables 3 and 4 that, as usual, the majority of lesions were of grades 1 and 2, according to Broders' method of grading carcinoma. Most of the growths of grades 1 and 2 which were also classified as type C, according to Dukes' classification, were of long duration. In all cases of lesions of type C, lymphatic involvement is present.

PREOPERATIVE PREPARATION AND OPERATIVE TECHNIC

No two surgeons work exactly alike and thus the technic of operations of the same type performed by different surgeons was not exactly the same. Neither was a standard type of anesthesia employed in the two series of cases. Time and space do not allow a detailed description of the variety of technics used by the various surgeons who operated on these patients.

Since the entire operative or hospital mortality rate, and particularly that portion of it which might possibly be attributed to error in technic, is small in each group, it can be said that regardless of whether or not colostomy is performed, if well-known and fundamental principles of surgical anastomosis are kept in mind, deaths will be few. The two most important factors to consider in this connection are, first, an accurate union of the ends of the sigmoid and rectum, and, next, certainty that the line of anastomosis is not under tension.

A factor that is of utmost importance in producing a favorable operative result, uncomplicated by infection, is a clean bowel to work on and, therefore, preoperative preparation is essential. Streptomycin, phthalylsulfathiazole, sulfathaladine and succinylsulfathiazole (sulfasuxidine) are at present the drugs of choice for use in preoperative preparation. In most of the cases in our two series the last-mentioned drug was used in preoperative preparation. According to the plan usually employed, about four to seven days are required for preparation of the colon for operation; the length of preparation depends on the individual situation. During this period irrigations are used in conjunction with a total of 1,000 and 1,200 grs. (65 to 78 Gm.) of sulfasuxidine which is administered orally in divided doses every four hours.

Another very good reason for making certain that the colon is actually well prepared is that an open type of anastomosis is necessary in practically all cases because of the site of the lesion.

MORTALITY

Nine deaths occurred in the total number of 200 cases of low anterior segmental resection, with or without colostomy, in which the growths were situated from 5 to 15 cm. above the anus, a mortality rate of 4.5 per cent.

In the 100 cases in which colostomy was performed concomitantly with the resection, three deaths occurred, a mortality rate of 3 per cent. One death occurred suddenly shortly after the patient awakened from the anesthesia at the time of closure of the colonic stoma. The cause is not known because necropsy was not permitted. One patient died one week after he left the hospital, after resection and colostomy had been accomplished but before the vent had been closed. Death in this case was caused by separation of the anastomosis, formation of a hematoma and infection. Another patient died on the fifth day after the primary operation, from causes unknown. Necropsy was not permitted.

The mortality rate was 6 per cent in the 100 cases in which resection and primary anastomosis were performed without accompanying colostomy. Four of the six patients who died succumbed by the eighth postoperative day, from pulmonary embolism, myocardial failure or cardiovascular accident. One patient died on the eighth postoperative day from separation at the site of the anastomosis and resultant peritonitis. The other patient died on the thirtieth postoperative day as a result of partial separation at the line of anastomosis.

Colostomy was performed but death resulted from peritonitis and shock.

MORBIDITY

In comparing the two operative procedures, we found that the most striking difference was in morbidity.

Of the 97 patients who survived low anterior resection with accompanying colostomy, four were out of the hospital within one month, 64 required time that extended into the second month, 28 into the third month, and one, into the fourth month. An analysis of the total time required before the surgical dismissal was granted shows that seven patients in this series were dismissed from our care in the second month, 44 in the third month, 30 in the fourth month, five in the fifth month, four in the sixth month and one patient each in the seventh, eighth, tenth and eleventh months after operation. Of the three remaining patients, one did not return for closure of the stoma and there was no further correspondence in the case; in one case the colostomy closed spontaneously seven months after the application of clamps to the spur, and in one case there was a recurrence at the site of the resection, before closure of the colostomy had been performed and so it was left open of necessity.

Of the 94 patients who survived the one-stage anterior segmental resection without colostomy, 77 were dismissed from the hospital in one month or less (16 of these within two weeks and 44 more within three weeks) and 17 more were dismissed in less than two months. An analysis of the total time required before dismissal from our care altogether in this series of cases shows that 33 patients, or a third of the total, were dismissed in less than three weeks, 28 more in less than four weeks, 32 more in the second month and one more in the third month after operation.

RÉSUMÉ

Two hundred cases of carcinoma of the rectum, rectosigmoid and lower portion of the sigmoid situated from 5 to 15 cm. from the anus have been reviewed.

In 100 consecutive cases, anterior segmental resection was performed with concomitant colostomy and end-to-end anastomosis between the sigmoid and rectum. In another series of 100 consecutive cases, the operation was essentially similar except that colostomy was not performed.

It is pointed out again that rare exceptions and especially in cases amenable to these procedures, the line of lymphatic spread in the upper portion of the rectum and the rectosigmoid is upward.

In the 100 cases in which the operation was accompanied by colostomy, the mortality rate was 3 per cent. In the 100 cases in which the operation was not accompanied by colostomy, the mortality rate was 6 per cent. Four of the six deaths in this group of cases were due to pulmonary embolism or were cardiovascular in origin.

The greatest difference between the results of the two operations, the one with and the one without colostomy, was in morbidity.

In the series in which colostomy was not performed, 82 per cent of the patients were out of the hospital within one month and about 65 per cent of the patients were dismissed from our care within that period. All but one of 94 were dismissed in less than two months after operation.

In the series in which resection was accompanied by colostomy, 4 per cent of the patients were out of the hospital but none were dismissed from our care at the end of the first month after operation. Only seven of the 97 patients were dismissed with all our care completed two months after operation. By the end of the fourth month, the operation and postoperative care had been completed in 83 per cent of the cases.

Because the surgical procedures have been performed too recently, the survival rates must be determined at a future date, at which time comparison of the eventual results of other surgical operations for carcinoma in the same segment of the bowel can be made.

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Discussion.—Dr. Lon Grove, Atlanta: I shall not attempt to discuss the merits of anterior resection because our series is small and the time elapsed since operation is too short. After discussing this problem with Wangensteen, Dixon and others, we decided approximately eighteen months ago that we would do anterior resection ir properly selected cases.

During the last eighteen months we have done thirteen anterior resections for carcinoma of the lower sigmoid, recto-sigmoid and upper rectum. (slides)

There have been eight of the upper rectum, one of the recto-sigmoid and four of the lower sigmoid. These patients were all prepared with sulfasuxadine and none had colostomy. The lowest growth was 6.5 cm. above the pectinate line. There have been no deaths. The last patient was operated on four days before this slide was made, but he is now ten days post-operative and they report his condition satisfactory.

We had in this series two very remarkable complications; acute cholecystitis which occurred on the tenth and eleventh postoperative days, respectively. These patients were observed for 48 hours without improvement, and then cholecystectomy was done through a right sub-costal incision, with recovery.

Prior to the first of our cases, we had seen two patients operated on elsewhere, and both had a stricture of the ampula. It occurred to me that if we could flare the end of the sigmoid to fit the ampula we could avoid this. The second slide illustrates how this was done.

The first twelve of these cases have had subsequent proctoscopic examination and none has shown evidence of stricture.

Dr. Donald S. Daniel, Richmond, Va.: I appreciated Dr. Estes' remarkable report. It certainly emphasizes the close relationship of polyps and carcinoma. I also congratulate

Drs. Graham and Mayo for bringing this most important subject, carcinoma of the rectum and colon, before us.

In my discussion I would like to give an incomplete report of carcinomas of the rectum and colon. Since 1938, Dr. Frank Johns, Dr. William Johns and I have seen 124 cases of carcinoma of the rectum and colon, of which 83 per cent were operable with an operative mortality of 4.8 per cent. Of the 124 cases, 118 were admitted to the Johnston-Willis Hospital in Richmond. There were 56 carcinomas of the rectum; five were inoperable; one refused operation. Nine received the Kraske, and 41 the one-stage combined abdominoperineal resection. No attempt was made to preserve the sphincter in any case. There were three deaths, or an operative mortality of 5.7 per cent in the rectal cases.

There were 68 carcinomas of the colon; 16 were inoperable; one refused operation. There were seven Mikulicz' operations with two deaths. There were 44 primary end-to-end aseptic anastomoses performed with the use of the Stone technic and clamps, with no deaths.

I would like particularly to emphasize this last fact. Here we have seven Mikulicz operations with two deaths and 44 primary aseptic anastomoses with no mortality. In the light of these statistics, meager, though definitely indicative, and of our experience, we prefer primary end-to-end aseptic anastomosis as advocated by Stone in comparison with the obstructive Mikulicz, because of the following considerations:

1. It is natural, physiologic, and aseptic.
2. It allows a more radical removal of the pathologic colon and the underlying glandular-bearing mesentery.
3. The morbidity and infectious complications are at a minimum.
4. It obviates secondary and sometimes tertiary closure of the colostomy.
5. It allows the patient to get up earlier, which in turn may have some influence in prevention of phlebidides and the dreaded pulmonary complications.
6. It definitely shortens the hospitalization by half, which is less expensive to the patient and, incidentally, allows more much needed hospital space.
7. It eliminates the colostomy mental depression which retards convalescence.
8. Last, and most important, so far as our results are concerned the mortality is definitely low.

Dr. Roger G. Doughty. Columbia, S. C.: I have no series of cases to report that would be worthy of interest, in the light of what you have just heard. Recently, however, there have been two patients that I think might be called to the attention of the Association. One was a relatively young woman, in whom, from the x-ray report, there was agreement on the presence of a lesion in the rectosigmoid. The x-ray man passed up an area that looked a little abnormal. I was not absolutely satisfied about that area of the bowel. At operation this patient was found to have very definite carcinoma in the area that had first been diagnosed by barium enema as malignant. She had also an equally well developed malignant area approximately ten inches higher up. Resection of both lesions was done, and she was found to have malignancy in both areas developing from polyps, together with several other small polyps which were not found in the x-ray; could not be found; too small.

We did a resection and end-to-end anastomosis. (For a long time I have done essentially what Dr. Grove has done; instead of splitting the gut, we have angled it back from the mesentery border to enlarge the opening). I was not satisfied with this anastomosis at the time, and three months later, to satisfy myself, I had a barium enema done and I received a report of constriction in the area of operation. We found a stricture of moderate extent and the gut was then completely angled back and we got a good result.

The second patient was a man with a mass in the epigastrium and obvious carcinoma of the sigmoid in the x-ray. He had carcinoma of the rectosigmoid and also an area in the transverse colon which looked like carcinoma. We were misled in this by the plates. I simply want to emphasize the fact that because we have one lesion in the gut demon-

strated by x-ray, it does not mean that we might not have another.

Dr. Richard B. Cattell, Boston: I should like first to express my appreciation for the privilege, as a guest, of discussing these three papers on large bowel surgery.

We have had a similar family group to that presented by Dr. Estes, in which congenital polyposis occurred as a mendelian dominant characteristic. At the time of our original observation 13 years ago, four of a family of five children were found to have diffuse polyposis of this type. One or more carcinomas developed in each of the four children between the ages of 32 and 39. All four are now dead from malignant disease. One had hemicolectomy and abdominoperineal resection with subsequent liver metastases; one had a palliative abdominoperineal resection; a third had carcinoma of the cecum, carcinoma of the sigmoid and carcinoma of the rectum, and the fourth refused surgery. In the past, some of us have lacked courage in advising early colectomy during the second or third decade, and I was pleased that Dr. Estes urged complete removal of the colon. In one case we removed the colon, anastomosing the ileum to the rectosigmoid, and followed the patient's course at frequent intervals, doing fulguration of polyps in the rectum on each visit. We felt safe in doing this, yet carcinoma developed at the site of anastomosis, and because of the extent of the disease in spite of radical resection, I feel sure the patient will lose her life. Dr. Lahey has reported one of these cases in which the patient had four simultaneous carcinomas in various positions in the colon. We have a number of patients in whom, after repeated fulguration of scattered polyps of the rectum, we have successfully removed the colon, with anastomosis of the ileum to the rectum. Based on our experience, we feel there will be few patients in whom this can be safely done and we recommend that total colectomy with ilostomy be carried out for patients with this form of polypoid disease.

Dr. Graham is to be congratulated on the large amount of material which he has accumulated and presented to us relative to the present surgical opinion for the treatment of carcinoma of the rectum. The extensive statistical data which he has so fully presented will require careful study. From our experience, we agree with him that most patients with this lesion will require abdominoperineal resection.

Dr. Mayo presented a large experience with low anterior resection for carcinoma of the rectosigmoid and upper rectum, with excellent results for the period of observation. This experience, together with that previously reported by Dixon, Wangensteen and others, should permit proper evaluation of this procedure. We are unwilling to accept resection of carcinoma in this location with such a narrow margin beyond the lesion. Furthermore, we find ourselves unable to select cases suitable for this type of operation. We have employed anterior resection with anastomosis in but few cases. Even with a small lesion which we think is favorable, frequently the pathologist reports evidence of disease well beyond the area that could be determined at the time of operation.

To illustrate our position relative to carcinoma of the rectum and rectosigmoid, I should like to report on 426 patients operated upon from 1944 to 1946 inclusive. Three hundred eighty-three abdominoperineal resections were done, constituting 98 per cent of all resections performed during this period. The mortality in this group was 6 per cent, and during this time a resectability rate of 94 per cent was maintained. In view of the fact that we have reported from our clinic a large number of two-stage resections, we feel it wise to state our present position relative to abdominoperineal resection. There are still some patients with perforated lesions with abscss who are best treated by the two-stage operation. It is our opinion that some form of an abdominoperineal resection offers the best chance for cure of carcinoma of the rectum and rectosigmoid.

Dr. W. L. Estes, Jr., Bethlehem, Pa. (closing): I think Dr. Cattell has brought out a very important point, i.e., the question of the operation in patients with multiple polyposis, and is conservatism justified? Certainly the operation of choice is total colectomy including complete resection of the rectum. On the other hand there may be certain cases in which a more conservative attitude might safely prevail. Cases in

which the rectum is preserved have to be carefully chosen, because there are on record instances of carcinomas occurring in these rectums that have been left, in spite of fulguration of the polyps they contain. Therefore, cases in which we are conservative and leave the rectum, must be only those which can be kept under close observation following definitive treatment, and certainly if any suspicion of actual ulceration or carcinoma develops, complete removal of the rectum must promptly follow.

Furthermore, patients with a rectum remaining should be proctoscoped at least every six months. If repeated fulguration fails to control the polyposis the rectum should be sacrificed without delay.

Finally, I want to emphasize again that the members of these polyposis families who are found symptom free can never be considered free of the disease unless a complete diagnostic survey proves negative. The mere fact that they have had no symptoms in no way eliminates the possibility that they may be victims of the disease.

DR. CHARLES W. MAYO, Rochester, Minn. (closing): There is one point in the examination of multiple polyposis or adenomatosis of the colon that too often is neglected. In view of the fact that in about 5 per cent of the cases of congenital colonic polyposis there also are polyps in the stomach or small intestine, roentgenographic studies of these portions of the digestive tract should be included for complete examination in each case.

To close the discussion of my own particular presentation on the subject of low segmental anterior resection and primary anastomosis, I might say that when a malignant lesion exists in the region 5 to 15 cm, above the anus, preparation for a one-stage combined abdominoperineal resection should be carried out in all such cases. The final decision as to the surgical method to be chosen is made only after laparotomy or, actually, very often only after mobilization of the growth has been accomplished.

The abdominal portion of a low segmental resection and anastomosis should be performed just like that of a combined abdominoperineal resection. If this cannot be accomplished so that sufficient mobile colon is left to enable one to perform an end-to-end anastomosis without tension, segmental resection definitely should not be performed and, in my opinion, the case falls into the group in which combined abdominoperineal resection should be carried out. In some instances I have performed segmental resection and have started to make the anastomosis when the pathologist's report has prompted me to change my opinion regarding the technic to be used, and I have shifted to a combined abdominoperineal resection. This too can be accomplished without too much difficulty.

Despite the written and spoken word on the subject of colostomy, if the anus, with proper control, can be kept without sacrifice of the life or longevity of the patient, I want to perform an operation that does not sacrifice it.

THE SURGICAL TREATMENT OF PEPTIC ULCER*

A Comparison of the Results of Gastro-enterostomy, Gastric Resection and Vagotomy at the Duke Hospital

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RE-EVALUATION OF SURGICAL PROCEDURES used in the treatment of peptic ulcer has been stimulated by the introduction of vagotomy by Dragstedt.[1] While final appraisal of the results of vagotomy is not yet possible, enough experience with this operation has accumulated to enable a comparison to be made between its results and those of previously accepted surgical procedures. It is our purpose to analyse the results in the surgical treatment of peptic ulcer at the Duke Hospital during the past eight years and to attempt to evaluate the place which vagotomy may hold along with gastro-enterostomy and gastric resection in the surgical management of this condition.

In the eight years prior to January 1, 1947, 265 patients with gastric or duodenal ulcer were operated upon at the Duke Hospital. Sixty-eight of these had had a gastro-enterostomy, 123 gastric resection and 77 vagotomy.†

GASTRO-ENTEROSTOMY

Patients selected for gastro-enterostomy were usually in the older age group with symptoms of gastric retention. Although 75% of these patients were over 45 years of age there were three between 20 and 30 and twelve in the age group 30 to 40. All had duodenal ulcers except one in whom a large gastric ulcer with posterior perforation was misdiagnosed as an inoperable carcinoma. All had obstruction at the pylorus with from 25% to 100% retention of barium at the end of six hours.

The operations were done by 11 members of the resident and visiting staff. Fifty-one were posterior and 17 anterior anastomoses. There were three non-fatal complications, two from pneumonia and one wound infection. Thirteen, or 19%, had malfunctioning stomas, but in ten of these symptoms subsided after continuous syphon drainage of the stomach through an intra-nasal catheter. Three, or 4.4%, were relieved only by a secondary operation.** The incidence of malfunctioning stomas after anterior and posterior anastomoses was the same.

There were five hospital deaths, giving an operative mortality of 7.3%.

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* Read before the Southern Surgical Association at Hollywood Beach, Florida, Thursday, December 11, 1947.

† Three had gastric resections followed in from 3 to 5 years by vagotomy for marginal ulcer. They are included in both groups.

** In one an enterostomy was performed between proximal and distal jejunal loops. In another a plastic procedure was done between the two loops of jejunum similar to a Finney pyloroplasty. In the third patient in whom the anastomosis had been done over a Wagensteen clamp the stomach had not been opened at the time of the original operation and it was necessary to take the anastomosis down and complete the gastro-enterostomy.

One of these was from an intra-intestinal hemorrhage, presumably from the original ulcer or the suture line on the seventh day, and is the only death directly attributable to the operation. The other four deaths were caused by pulmonary embolus, coronary occlusion, cardiac failure and uremia, one each.

Of the 63 patients discharged 54 have been followed. Forty-eight (88.8%) have been entirely relieved of digestive symptoms, four having died of unrelated conditions. Three (5.6%) have had symptoms of recurrence, one having died of a gastro-intestinal hemorrhage. Three others have multiple complaints and are recognized as having a psychoneurosis, one being a morphine addict. None of the latter three have evidence of recurrence of their ulcer.

GASTRIC RESECTION

When medical measures failed gastric resection has been the operation of choice for patients whose ulcer pain was unrelieved, for those with uncontrollable bleeding (Reference to bibliography) and for those in whom the possibility of malignancy existed. These were usually in patients of the younger age group, although one-third of the group with duodenal ulcer who had resections done were over the age of 50.

These operations were performed by 11 residents and four members of the senior staff. All had an end-to-side anastomosis between the stomach and jejunum, 78 being anterior and 45 posterior to the colon.* The location of

TABLE I.

Location of Ulcer in Patients with Gastric Resection

Duodenum	83
Stomach	31
Marginal	5
Stomach & Duodenal	4
Total	123

the ulcer and indication for operation in patients with resection is shown in Tables I and II.

Malfunctioning stomas developed in 18 or 14% of the cases but in 14 symptoms subsided with stomach drainage through an intranasal tube. Four patients required reoperation and were relieved by a plastic type of enteroanastomosis at the stoma site. Other non-fatal complications are shown in Table III.

Hospital deaths occurred in 10 of the 123 cases with resection and in an

*Additional procedures included disconnecting a gastro-enterostomy and resecting a marginal ulcer in four cases, taking down a gastrocolic fistula once, resecting the head of the pancreas with choledochoduodenostomy on a mistaken diagnosis of carcinoma of head of pancreas once, reconstruction or implanting the common duct into the duodenum twice (in one case where it was damaged and in another case where the ulcer involved the papilla of Vater), cholecystectomy once, and repair of diaphragmatic hernia once.

eleventh patient several months after discharge as the result of an operative error, giving an operative mortality of 8.9%. Three of these deaths occurred in patients who were operated upon as emergencies because of acute hemorrhage. In elective operations there were 8 deaths in 120 cases giving an operative mortality of 6.6%. Of these 8 deaths five occurred because of damage to structures in and about the duodenal stump, two were the result of pulmonary embolism and one was a cardiac death in a patient with rheumatic heart disease. Five of the deaths were directly attributed to the operative procedure; two as a result of duodenal or pancreatic duct leaks into the peritoneal cavity, two from common duct injuries and one presumably followed an injury to the hepatic artery.

Of the 112 patients who survived resection, 100 or 89.2% have been followed. Eighty-four of these (84.0%) have been entirely relieved of digestive symptoms, seven having died of unrelated conditions. Five (5.0%) have had recurrences, among whom two have died of their disease, both following reoperations elsewhere, one for perforation and one following total gastrectomy. The other three patients with recurrences had vagotomies in this clinic. One of these has been entirely well following vagotomy, another, though relieved of his ulcer symptoms is incapacitated by the post-vagotomy syndrome characterized by diarrhea, intestinal cramps, weakness and failure to gain weight. The third continues to have mild, atypical ulcer-like symptoms although no ulcer can be demonstrated by roentgen-ray or gastroscopy.

TABLE II.

Indication for operation in Patients with Gastric Resection

Unrelieved Pain	28
Pain and Obstruction	43
Unhealed Gastric Ulcer	31
Uncontrolled Hemorrhage	16
Marginal Ulcer	5
Total	123

Eleven patients, in addition, continue to have gastro-intestinal complaints although their original symptoms have been largely relieved and there is no evidence of a recurrence of their ulcer. Two of these have mild, atypical ulcer-like symptoms, three have multiple complaints and are recognized as being neurotic while six have symptoms of the post-gastrectomy syndrome. These latter symptoms include fullness after meals, a tendency to regurgitate food after eating, nervousness, weakness, dizziness and inability to regain strength and weight.

VAGOTOMY

Grimson and his co-workers[3] have reported in detail the first 57 of the 77 patients treated by vagotomy in the past three years in this clinic. All were

TABLE III.

Non-fatal Complications Following Gastric Resection

Pneumonia	6	Lung Abscess	1
Wound Disruption	5	Spinal Anesthesia Reaction	1
Atelectasis	2	Parotitis	1
GI Hemorrhage	2	Wound Infection	1
Pulm. Tbc.	1	Duodenal Fistula	1

TABLE IV.—*Comparative Results Following Gastro-enterostomy, Gastric Resection and Vagotomy for Peptic Ulcer*

	No. Cases	Non-fatal Comp. %	Gastric Retention %	Op. for Retention %	Mort. %	RESULTS				
								No Recurrence—Still Complain		
						Well %	Recur %	Atypical ulcer-like pain %	Multiple Comp. %	Post-op. Syndrome %
G.E.	68	4.4	19.1	4.4	7.3	88.8	5.6	0.0	5.6	0.0
RES.	123	17.0	14.6	3.2	6.6	84.0	5.0	2.0	3.0	6.0
VAG.	77	42.0	36.0	14.3	1.3	80.5	2.6	9.0	0.0	7.8

transthoracic vagotomies. There were 40 duodenal, 10 stomal and 7 gastric ulcers in the series. Gastro-enterostomy was also performed in 12 of the cases at the time of vagotomy.

Non-fatal complications in 13, or 42%, of the first 31[4] of these cases included pneumonia in 5, pleural effusion sufficient to shift the mediastinum in 3 and atelectasis in 5. One patient in the series of 77 cases died 17 days following a combined vagotomy and pyloroplasty due to "rupture of the stomach after acute gastric dilatation and later a terminal massive hemorrhage from a duodenal ulcer"[3] (mortality 1.3%).

Of the 77 patients[5] 62, or 80.5% have had good results. Two have had persistent ulcers both of which have been demonstrated at operation, at which time subtotal gastric resection was performed in this clinic. Seven others have mild or atypical ulcer-like pain although roentgen-ray examination has not demonstrated a recurrence. A little more than half of the patients in the entire group have had temporary, intermittent or moderately severe diarrhea. Four of these have had severe diarrhea and one died two years following vagotomy of this condition. Symptoms of retention of food in the stomach have been considered of major importance in 28 or 36% of the cases. Pyloroplasty or gastro-enterostomy has been necessary as a secondary operation to relieve major symptoms of retention in 14.3% of all these vagotomized patients.

DISCUSSION

None of the surgical procedures used in the treatment of peptic ulcer is ideal. (Table IV.)

Gastro-enterostomy alone is an entirely satisfactory procedure in the older patient with duodenal ulcer whose major symptom is from obstruction. When the indications for its use are rigidly confined to this group of patients, we would consider it the procedure of choice[6] and see no need to discard it in favor of gastric resection in all cases.[7, 8] Vagotomy alone or in combination has no place in this group of patients.

Malfunctioning stomas have been a very real source of trouble with us as with others[9] following gastro-enterostomy and gastric resection. Why the stoma should not function properly in all cases is perplexing. Kinking or adhesions about the anastomosis, edema from hypoprotinemia, or pressure from a thick omentum or colon may be the cause in some cases. However, we have seen stomas function poorly when no adequate cause could be demonstrated. In the few cases which do not subside with drainage through an intra-nasal catheter a plastic procedure similar to a Finney pyloroplasty between the proximal and distal loop of jejunum at their attachment to the stomach[10] seems to be the best procedure. In more than 300 cases Allen[11] has used successfully a proximal jejunostomy tube whose tip lies in the stomach to prevent this condition. In many cases he also uses a jejunostomy tube for feeding.[12] We have had no experience with these procedures but

have used, in occasional cases, tubes passed through a gastrostomy opening and extending into the stomach or jejunum or both for the same purpose.

When medical measures fail, gastric resection is the procedure of choice in patients with resectable gastric ulcers and also in those with acute hemorrhage. Vagotomy has no place in either of these conditions. The possibility of carcinoma in the gastric ulcer which does not heal promptly is so great as to preclude any surgical procedure short of resection. In the presence of continued bleeding from a peptic ulcer the only satisfactory measure is a direct approach to the ulcer. In our experience this must be a resection.

There then remains a large group of ulcers, all in the duodenum, with pain which fails to respond to medical measures. They are usually in the younger age group, have high gastric acidity with or without obstruction and usually give a history of one or more hemorrhages or of perforation in the past.

Gastric resection in this group will be followed by a perfectly satisfactory result in about 85% of the cases. The operative procedure, however, may be difficult when an active ulcer with posterior penetration has attached itself to the pancreas or portal triad. Five of our eight deaths in elective resections were caused by leakage at the duodenal stump or damage to adjacent structures. This experience has influenced our decision to "exclude" thiry-five percent of duodenal ulcers when resection is done. This is in contrast to the experience of many[13, 14, 15, 16] who prefer to remove the ulcer in all except a very small percentage of cases.

In our 31 cases in which the ulcer was not removed the duodenum was inverted above the ulcer in 8 cases, while in 23 the pyloric antrum was divided 6 to 8 cm. above the pylorus. In 12 of the latter cases, the antral mucosa was removed and in 11 of the earlier cases it was left in place. No difficulty with leakage of the closure was encountered in any of these cases. It has been our practice to invert the antral stump though Wangensteen[17] has described a method of closure by apposition.

At follow-up only one in the group of 23 antral exclusions had a recurrent ulcer. The mucus membrane had been left in his pyloric stump. At reoperation the pyloric antrum and more of the stomach were resected. Subsequently he developed another stomal ulcer and died in another hospital following total gastrectomy. The universal opinion of those using antral exclusions[17, 18, 19, 20, 21] is that the antral mucosa should be removed in all cases, and such is our present practice. The incidence of recurrence of ulcers following antral exclusion in our series is less than that in the group of resections as a whole. This is in keeping with the experience of Allen and Welch[22] (1946) and Wangensteen[28] (1947). The latter author reports no stomal ulcers following antral exclusions in a series of just under 100 cases.

The post gastrectomy syndrome characterized by eructations, fullness after meals, weakness, dizziness, inability to gain weight or strength and sometimes accompanied by anemia has been reported in from 6% to 29%

of cases following subtotal gastrectomy[24, 25]. It has been attributed to precipitous emptying of the stomach (dumping syndrome) or to abnormal sugar absorption[26].

Vagotomy alone, while successful in relieving the pain of peptic ulcers in a high proportion of cases, is followed by such a high incidence of unpleasant side effects that it is doubtful if the procedure ever should be used alone. The 36% incidence of gastric retention of which one in three in this clinic has to have a secondary operation for drainage of a large dilated stomach is a serious complication and should lead to the abandonment of this procedure unless it be combined with gastro-enterostomy. Additional side effects include intestinal cramps, diarrhea and failure to gain weight and strength and occur in about the same ratio as the gastrectomy syndrome which follows gastrectomy.

Vagotomy may have a very real place when combined with pyloroplasty or gastro-enterostomy in the treatment of refractory duodenal ulcers in the younger age group. However, because each operation has its own group of complications, it would seem unwise to combine the two routinely and to add the complications of one procedure to those of the other. This combination of operations is frequently used by Dragstedt and is the routine practice of Grimson in our clinic at the present time. Their carefully studied results should be awaited before the combined procedure is generally adopted. Until then we feel that vagotomy should be reserved for the patient with marginal or recurrent ulcer following gastric resection, or gastro-enterostomy. Vagotomy has no place in the treatment of resectable gastric ulcers or of duodenal ulcers with uncontrollable hemorrhage or pyloric obstruction.

SUMMARY

None of the surgical procedures currently employed for peptic ulcer gives uniformly satisfactory results.

Gastro-enterostomy has given the highest incidence of success in our experience (88.8%) but is applicable only in a rigidly selected group of patients in the older age group with relatively inactive ulcers and a high degree of pyloric obstruction.

Gastric resection is the procedure of choice in patients whose ulcer gives intractable pain, in those with uncontrollable hemorrhage and in those with gastric ulcer when the ulcer does not heal promptly under a medical regimen. Results are satisfactory in 84% of our cases. Five percent have had recurrent ulcers, another 5% have multiple complaints without recurrence and 6% have symptoms of the postgastrectomy syndrome.

Vagotomy carries a low operative mortality. Thus far it is followed by definite evidence of recurrence in only 2.6% of cases although an additional 9% complain of mild or atypical ulcer-like pain without roentgen-ray evidence of reactivation of the ulcer. The high incidence of major symptoms of gastric retention (36%) of which one in three must have a secondary operation for

stomach drainage contraindicates its use unless combined with pyloroplasty or gastro-enterostomy. Additional unpleasant side effects which include intestinal cramps, diarrhea and failure to gain weight or strength occur in an appreciable group following vagotomy (7.8%).

Vagotomy routinely combined with pyloroplasty or gastro-enterostomy may hold definite promise in the treatment of active duodenal ulcers with intractable symptoms. Until carefully studied results of this combination of procedures have shown otherwise it seems unwise to combine the two and add the complications of one procedure to those of the other.

The greatest indication for vagotomy in our experience has been in the management of marginal or recurrent ulcers following gastric resection. Vagotomy has no place in the treatment of gastric ulcers, actively bleeding ulcers, or inactive ulcers with pyloric obstruction.

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Discussion.—Dr. Lon Grove, Atlanta, Ga.: I have enjoyed Dr. Gardner's paper. The series of cases I wish to report represents what might be expected from gastrectomy today in a good general hospital, even though there is no organized department of gastroenterology.

While we have done 168 consecutive gastrectomies, only 150 cases have been tabulated; the remaining 18 were done after the following slides were made.; It is only fair to state that these were all private patients and with two exceptions were done at Emory University Hospital, and most received private duty nursing.

Slide No. 1 shows the 150 cases with 102 duodenal ulcers, 41 gastric and seven marginal ulcers. The average duration of symptoms was 13 years. It is our policy today to operate on all gastric ulcers, while only the complicated duodenal ulcers are believed to be surgical. When massive hemorrhage occurs in the older age group, it is now our policy to institute surgery as soon as blood loss can be replaced, provided a previous diagnosis has been made. The younger age group is still being treated conservatively.

Slide No. 2 shows the various technics. Both the Poyla and the Hoffmeister technics have been employed, but we prefer the anticolic Hoffmeister method, removing two-thirds to three-fourths of the stomach, and when at all possible we are definitely committed to removing the ulcer even at considerable effort. When this has not been feasible, we have employed the Bancroft modification of the Finster exclusion method. We are now using a shorter jejunal loop than previously. We have found that if the stomach is completely free from the pancreas and the transverse colon is placed high behind the stomach, a proximal loop of not more than 16 to 20 cm. will be ample. This technic was adopted after a very unusual complication which occurred in an elderly woman. Five weeks following gastrectomy obstruction occurred, and upon exploration we found that the proximal limb of the jejunum loop, which was too long, had herniated between the pancreas and the colon, causing a high obstruction. Fortunately she recovered, but her convalescence was stormy.

Slide No. 3 shows the complications: Pneumonia 3; atelectesis, 4; phlebitis, 2; evisceration, 1; deaths, 1; mortality rate, .66 per cent. These were no non-functioning stomas that required subsequent surgery for relief; there were no leaking duodenal

stumps; no supplementary jejunostomies and no two-stage gastrectomies. While it is too early for a final report, there has been only one marginal ulcer complication. This patient has had a second resection and is now free of symptoms.

DR. FREDERIC W. BANCROFT, New York: I should like to say a word about the modified Devine operation for pyloric exclusion with excision of the mucosa of the antrum, which I reported before this Association in 1931.*

Throughout the years since I reported this series, I have operated upon quite a number of patients with excellent results, with the exception of one case which bled postoperatively and had to have the duodenal stump resected. Where the ulcer is low on the duodenum and one is afraid of the possibility of duodenal leakage postoperatively, I feel that this operation is well worth considering.

Since my report in 1931, I have modified the procedure by resecting the median portion of the stomach, leaving enough antrum so that the mucosa can be coned out and the stump closed without tension and the stomach can be resected to any extent that I feel is necessary. This does not complicate the procedure and, as you know, the middle portion is always easy to resect.

I should also like to say something about the study on vagotomy that is being carried out at the Veterans Hospital in New York. At a conference with Dr. Whipple, Dr. St. John, the Attendings and the Residents, we decided that we would do 50 transthoracic vagotomies in order to determine the actual benefit of the Dragstedt operation. The patients are selected by staff vote and are cases of pain with or without bleeding, but without gastric retention. We have felt that we have opportunity for unlimited follow-up. The night secretions are taken on all these patients and, if they are high and if the Hollander test shows a high acid, and if there is no gastric retention after six hours, we have felt that this is a sufficient indication. We have felt that it is inadvisable to do the subdiaphragmatic vagotomy with gastroenterostomy because we know that it took us ten years to find out the evils of gastroenterostomy without vagotomy. Therefore we have done the trans-thoracic vagotomy because we do not like to complicate the picture. We have felt that it might be possible that we might have to do a second operation if retention became accentuated after this procedure. We have also used it in cases of gastrojejunal ulcer.

Up to August, 1947, we operated on 19 of these cases. Of this group, 15 are reported as good, three fair and one failure. Our follow-ups since August have not shown any change in this analysis. Since August, 1947, 15 additional cases have been operated on. There has been one fair result because the patient had mild symptoms of pain after meals, and two of these cases have been classified as failures. One had to have a gastroenterostomy and the other, a subtotal resection. There have been a few minor chest complications which were largely due to fluid in the chest but which were readily relieved by aspiration. Our present feeling is one of mild skepticism because it is not a cure-all operation. Diarrhea has not been a noticeable postoperative finding in our series. There have been no deaths. We feel that this procedure is valuable because of its low mortality in carefully selected cases. It may be only a first stage, but certainly 80 per cent will be relieved without further operative procedure.

Most of our patients are veterans of World War II, young men, and we do not want to submit them to a subtotal gastric resection unless it proves necessary.

DR. DERYL HART, Durham, N. C. (closing): I will briefly re-emphasize some of my personal opinions as crystallized by this study:

1. Gastroenterostomy still has a definite place in gastric surgery, in certain well-selected cases.

2. Gastric resection has given satisfactory results in a relatively high percentage of cases, with few marginal ulcers.

3. The greatest operative risk lies in resection of duodenal ulcers densely adherent

*A Modification of the Devine Operation of Pyloric Exclusion for Duodenal Ulcer, Am. J. Surg., 223, 1932.

to or ulcerated into the pancreas, particularly when located some distance below the pylorus.

4. When the ulcer has eroded the pancreas, and is resected, it is safest to insert a drain down to this area to provide an outlet for pancreatic secretion in case a duct has been eroded.

5. In this series, the results following exclusion operations have been as good as following resections. Since such an operation with removal of the antral mucosa avoids all the special risks associated with resections of perforated or adherent duodenal ulcers in proximity to the bile ducts, it probably should be used more often. This is particularly true for those operators who do some stomach surgery, but who are less experienced in handling these complicated and difficult situations. Also, if there is any indication to do so, subsequent removal of the duodenal and gastric stump following healing of the ulcer is usually relatively easy.

6. Subtotal gastric resection is a mutilating operation, at times followed by symptoms of so-called "dumping syndrome", and at times by inability of the patient to regain his lost weight. However, we must not lose sight of the fact that denervation may be even more mutilating than resection insofar as function is concerned, and the complications following vagotomy have been higher than following other types of operative treatment for ulcer.

7. The immediate mortality following vagotomy is definitely lower than following resection. However, with the trend toward some type of operation to drain the paralyzed stomach in every patient having a vagotomy, this lower mortality for vagotomy may change.

In conclusion, we would say that we are favorably impressed with the percentage of excellent results following resections or exclusion types of operations, and in certain well-selected cases, following gastroenterostomy. Vagotomy is still in the experimental stage, and we feel we are not justified in performing such an operation without explaining this to the patient, and then only if the patient and the surgeon are willing to carry out careful postoperative studies at intervals for an indefinite period of time, in order to evaluate the procedure and determine its eventual place in the treatment of ulcer.

THE SURGICAL TREATMENT OF OBSTRUCTIVE LESIONS OF THE ESOPHAGUS*

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With the comparatively recent developments in thoracic surgery, many lesions of the esophagus which formerly received only palliation by means of a gastrostomy are now subjected to direct surgical attack. No doubt, there will always be a place for an artificial epi-thoracic esophagus. Many ingenious methods of constructing such an esophagus have been devised.[1, 2, 3, 4, 5, 6, 7, 8] Those who advocate these procedures do so on the grounds that, although multiple operations are necessary and morbidity is sometimes encountered in leakage at the anastomoses, they are safer than those methods in which the jejunum[9] or stomach[10,11] is brought up into the chest, and anastomosed to the proximal esophageal segment. Anastomosis of the stomach and esophagus within the chest may, in some instances, be hazardous, technically difficult, and prolonged. However, these hazards and difficulties are being overcome and good results from the latter procedure are being reported in increasing numbers.[9, 10] Restoration of normal continuity of the digestive tract is desired whenever any portion is removed or obstructed. If this can be achieved, it is preferable to an esophageal fistula, an artificial esophagus, a gastrostomy, an ileostomy, or a colostomy. Admitting the occasional necessity for the construction of an epi-thoracic esophagus, as was shown in a recent paper by Van Prohaska and Sloan,[6] the advantages of an intrathoracic esophagus are obvious.

In this paper I wish to report some experiences in the surgical treatment of achalasia of the esophagus, carcinoma of the cardiac end of the stomach, and cicatricial stenosis of the esophagus at the terminal, middle third, upper third, and cervical levels. Several advanced carcinomas of the esophagus have been observed, but none were operable, and palliative gastrostomies were necessary.

ACHALASIA

It is generally agreed that all patients with cardiospasm or achalasia of the esophagus should be given a fair trial with dilatations, as many will be relieved of their distressing symptoms by this procedure.[12, 13] In those cases in which dilatation fails, surgical intervention will be necessary to prevent serious malnutrition and even starvation. In addition to dysphagia, these patients complain of severe pain and "heart-burn" from esophagitis. This is due to actual digestion of the esophageal mucosa from the fermentation of food retained in the dilated esophagus. Avitaminosis is a contributing factor, as Fisher[14] has demonstrated by esophagoscopy in patients suffering from pellagra.

*Read before the Southern Surgical Association at Hollywood Beach, Florida, Thursday, December 11, 1947.

The etiology of cardiospasm is not well understood. Many methods have been employed in efforts to correct the resulting obstruction. Ochsner and DeBakey,[15] Bell,[16] Grimson,[17] and others have described in detail these different technics, all leading up to the currently popular and very satisfactory

FIG. 1

FIG. 2

CASE 3.—Achalasia of the esophagus.

FIG. 1.—Photograph 10th postoperative day (July 1947) showing extreme emaciation. Patient's weight 93 lbs.

CASE 3. FIG. 2.—Photograph October 1947. Patient's weight 117 lbs.

trans-abdominal esophago-gastrostomy based on the principle of the Finney pyloroplasty. This procedure has been well illustrated in a recent paper by Bell.[16] We have employed the method successfully in four cases, three of

which were true achalasias, the other being a case of cicatricial stenosis at the terminal end of the esophagus of undetermined etiology.

Case 1. *History*—Jefferson-Hillman Hospital No. 24276 C. G., colored female, age 18, had been a dispensary patient for several weeks, with a history of dysphagia of three years' duration. A diagnosis of achalasia of the esophagus had been made by roentgen-ray and esophagoscopic examinations. Repeated dilatations gave only temporary relief.

She was admitted to the hospital on August 14, 1946. At that time her weight was 95 lbs.

On August 19, 1946, a trans-abdominal esophagogastrostomy was performed. The postoperative course was smooth and when discharged on September 10, she was eating solid food without difficulty. She returned to the hospital for a check up in October,

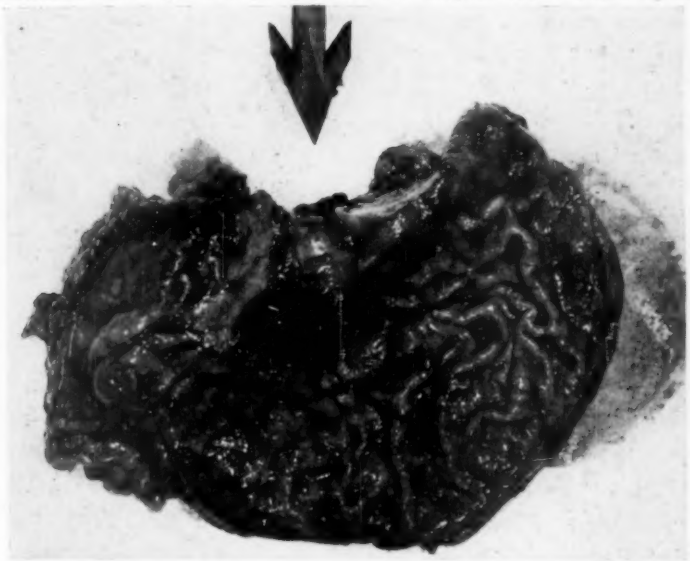

FIG. 3

CASE 6.—Carcinoma of cardia of stomach.
FIG. 3.—Specimen showing tumor and ulcer crater. Arrow indicates esophago-gastric junction.

1947. A barium study of the esophagus showed no obstruction; she weighed 130 lbs.; and had no complaints.

Case 2. *History*—Jefferson-Hillman Hospital No. 34645 S. M., a white male, age 65, was admitted to the hospital on January 11, 1947. He had suffered from dysphagia for the past three years. During this period he had been unable to eat solid food. His weight was 117 lbs. Heart-burn was a constant complaint. A diagnosis of achalasia was made by roentgen-ray and esophagoscopy. Dilatations gave no relief. On February 5, 1947, a trans-abdominal esophagogastrostomy was performed. His convalescence was smooth and he was discharged on the 14th postoperative day eating solid food. Post-operative roentgen-ray studies showed that the barium passed readily into the stomach. He has been followed at frequent intervals in the dispensary, weighed 133 lbs. in April, 1947, and was having no difficulty eating any kind of food.

Case 3. *History*—St. Vincent's Hospital, No. N526 E. M. C., white, female, married, age 38, was admitted June 29, 1947, with a history of dysphagia increasing in severity for the past two years. For three weeks before admission she was only able to swallow liquids. On admission her weight was 93 lbs. Prior to the beginning of her

illness, her average weight had been 120 lbs. Heart-burn was a constant symptom. Dilatations of the esophagus had given no relief. A diagnosis of achalasia was made by roentgen-ray and esophagoscopic examinations. On July 2, 1947, a trans-abdominal esophago-gastrostomy was performed. Her convalescence was smooth and she was discharged from the hospital July 13, 1947, swallowing without difficulty. She returned on October 28, 1947, for check up. Her dysphagia was completely relieved and she weighed 117 lbs.

Case 4. *History.*—St. Vincent's Hospital, No. M9956 S. B. R., white, female, married, age 44, was admitted to the hospital on May 22, 1947, with dysphagia of five years' duration. Dilatations at frequent intervals before admission, performed elsewhere, had not helped her. The dysphagia had been severe since April, 1947. She

FIG. 4

CASE 6. FIG. 4.—Postoperative X-ray.

weighed 110 lbs. at time of admission. She was able to swallow liquids, but no solid food. "Heart-burn" and regurgittion of saliva were constant symptoms. A diagnosis of stricture of the terminal esophagus was made by roentgen-ray and esophagoscopy. The etiology of the condition was unknown and there was no history of the ingestion of any escharotic agents. Since the strictured area was in the terminal esophagus, we elected

to try the achalasia operation, reserving the more formidable trans-thoracic esophageal resection and intra-thoracic esophago-gastrostomy for a later date in case an adequate lumen was not obtained. She was operated upon May 24, 1947, by the trans-abdominal route. The strictured area was incised longitudinally and an esophago-gastrostomy performed as for correction of achalasia. Her postoperative course was smooth. The lumen of the esophagus is adequate, and she can eat whatever she wishes, but must masticate her food well. She has been followed at frequent intervals and weighs 140 lbs.

Case 5. *History*—Jefferson-Hillman Hospital No. 38603 R. M., colored, male, age 32, was admitted on January 17, 1947, with complaint of dysphagia and substernal burning for a year. He had lost 50 lbs. in weight. A diagnosis of achalasia of the esophagus was made by roentgen-ray and esophagoscopy. The patient had a definite psychosis, due apparently to ignorance, superstition, and malnutrition, and committed suicide by jumping from a third story window while undergoing treatment preparatory to operation. An autopsy was obtained, and photographs show the conditions found in the diseased esophagus.

FIG. 5

CASE 6. FIG. 5.—Showing healed incision. 9th left interspace.

CARCINOMA OF THE CARDIAC END OF THE STOMACH

Due to the greater ease of exposure, the trans-thoracic approach to lesions high in the stomach is being extensively employed.[18, 19, 20, 22, 23]

A case of carcinoma of the cardia causing obstruction at the esophageal orifice was successfully operated upon using this approach.

Case 6. *History*—St. Vincent's Hospital, No. N1894, G. B., white, male, married, age 40, was first seen on September 10, 1947, complaining of dysphagia of three months' duration. He gave a history of peptic ulcer of several years' duration, and had been discharged from the regular Army on account of this disability. He was in good general condition otherwise, and weighed 180 lbs. He underwent esophagoscopy on September 10, and a specimen, positive for carcinoma of the stomach, was taken from a tumor mass projecting into the lumen of the esophagus at the esophago-gastric junction. On September 20, through a left trans-thoracic approach, the distal end of the esophagus and the upper two thirds of the stomach were removed. Intra-thoracic esophago-gastrostomy was performed. The postoperative course was uneventful and he left the hospital October 9, swallowing without difficulty, and has remained well.

The resected portion of stomach revealed a large ulcerated carcinoma of the cardia. Sections of the lower esophagus showed that the growth had not invaded this organ.

RESECTION OF THE ESOPHAGUS

In reviewing the literature, there seems to be unanimity of opinion that lesions of the lower third of the esophagus are best treated by resection and intra-thoracic esophago-gastrostomy.[18, 20, 21, 23, 24] However, in dealing with

lesions of the upper two-thirds, there are two schools of thought. One favors the performance of the plastic type of epi-thoracic esophagus.[1, 2, 3, 4, 5, 6, 23] The other advocates mobilization of the stomach or jejunum,[9, 10, 11, 25] with the performance of an intra-thoracic esophago-jejunostomy or gastrostomy, which may be carried out as high as the suprasternal notch. We have performed three esophago-gastrostomies according to the technic of Sweet.[10, 25]

Case 7. *History*—Jefferson-Hillman Hospital No. 25219 G. D., colored, female, age 28, was admitted to the hospital on November 11, 1946. In June, 1946, she had swallowed

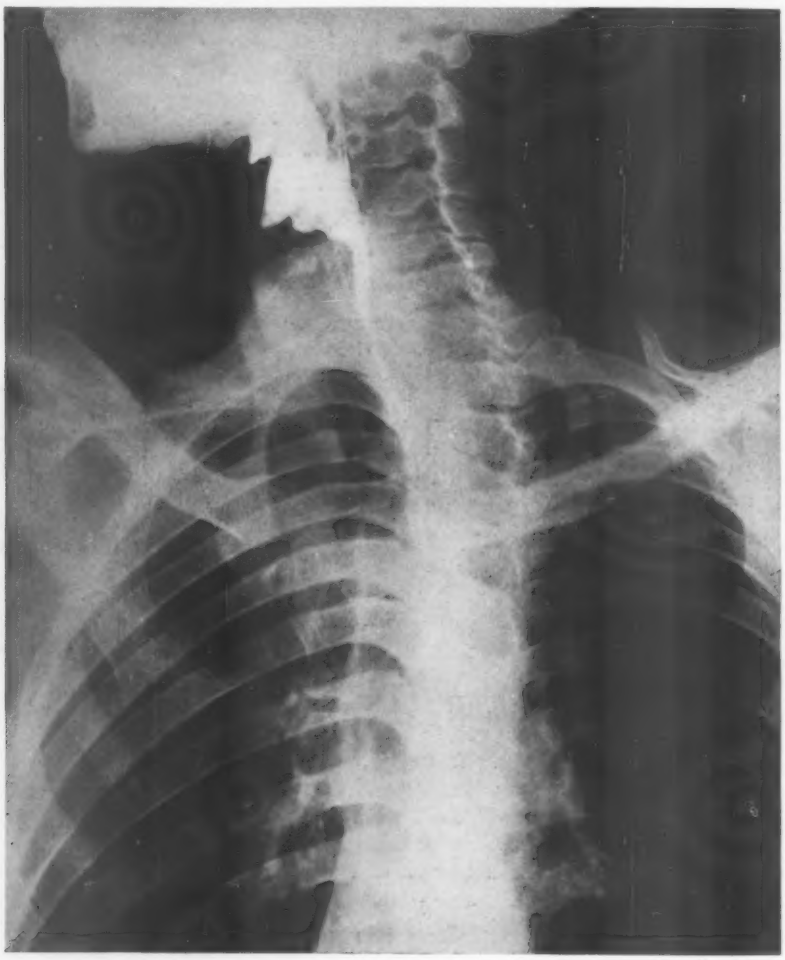

FIG. 6

CASE 10.—Lye stricture of esophagus high in the cervical portion.
FIG. 6.—X-ray showing level of stricture.

lye. She had several admissions to the hospital for dilatations of the resulting stricture. These dilatations gave only temporary relief. Her weight was 113 lbs. The stricture lay at the level of the arch of the aorta. On November 20, 1946, a sub-total esophagectomy with high intrathoracic esophago-gastrostomy following the method of Sweet was performed. In her postoperative course, fluid accumulated in the pleural cavities. This

was aspirated and both lungs expanded. Otherwise, her postoperative course was smooth. She was discharged December 14, 1946, swallowing solid foods without difficulty. She was readmitted to the hospital in October, 1947, for a check up. She weighed 120 lbs., and was swallowing without difficulty. She ate a full diet and worked every day. Roentgen-ray studies showed a well functioning anastomosis.

Case 8. *History*—St. Vincent's Hospital, No. N2142 W. M. H., white, female, married, age 41, was admitted to the hospital on October 6, 1947. When she was two years of age she swallowed lye, and an extensive stenosis of the esophagus resulted. This began at the level of the aortic arch and extended downward, involving the lower two-thirds of the organ. Dilatations had been carried out from time to time, but none for the preceding four years. She was said to have weighed 130 lbs. five years ago, but at the time of admission her weight was 97 lbs.

On October 11 a sub-total esophagectomy with high intra-thoracic esophago-

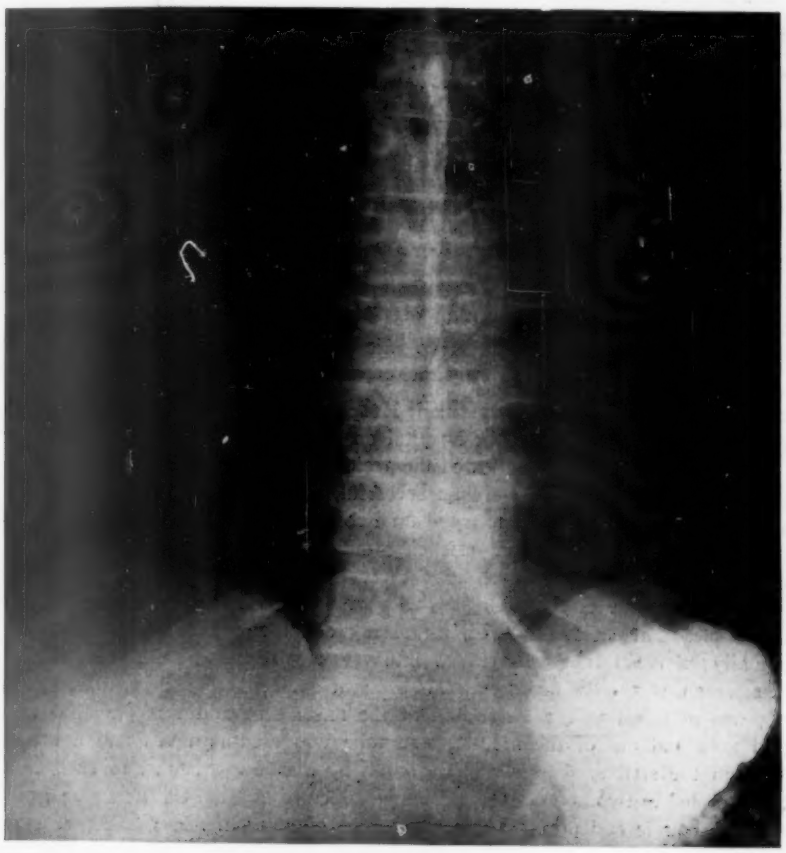

FIG. 7
CASE 10. FIG. 7.—Postoperative X-ray showing barium passing freely into stomach.

gastrostomy was carried out. The operation was unattended with any special technical difficulty and abundant fluid and blood replacement was employed. For two days her condition appeared quite favorable, but death took place suddenly on October 13. Autopsy showed normal progress of healing with no leakage at site of anastomosis. There was a moderate amount of sero-sanguinolent effusion in the left chest, which was to be expected, and which usually requires aspiration in cases that progress favorably. The exact cause

of death was not ascertained. My impression is that we over-estimated the ability of this debilitated patient to withstand so formidable an operation.

Case 9. *History*—Jefferson-Hillman Hospital, No. 1956 E. M., colored, male, age 4, swallowed lye in July, 1945, resulting in an esophageal stricture just below the level of the clavicle. A gastrostomy had been performed, and he had been followed in the dispensary for two years. His nutrition was only fairly well maintained on the gastrostomy feedings at home and he had several admissions to the hospital for attempts at dilatation of the stricture and for high caloric gastrostomy feedings. Due to his poor economic environment it was becoming quite a problem to obtain adequate diet for him, and unless he stayed in the hospital, malnutrition became marked.

On January 20, 1947, a sub-total esophagectomy with intra-thoracic esophago-gastrostomy at the level of the suprasternal notch was performed. While the location of this stricture was very high, there were no technical difficulties in freeing the esophagus and in making the anastomosis. The child died suddenly only 24 hours after operation. The exact cause of death was not ascertained, as an autopsy was refused.

STRICTURE OF THE CERVICAL ESOPHAGUS

A unique type of esophageal stricture is that in which the ingestion of lye or other escharotic agent causes a burn at the laryngo-esophageal junction or in the upper cervical esophagus. When dilatations of strictures in these locations are unsuccessful, relief of the obstruction is extremely difficult, since neither the stomach nor the jejunum can be brought up this high, and the cervical stump cannot be brought to the surface of the neck for anastomosis with an epi-thoracic esophagus.

We present a case of cicatricial stenosis of the upper servical esophagus corrected by longitudinal division of the stricture and reconstruction of an adequate lumen over a bougie.

Case 10. *History*—Jefferson-Hillman Hospital, No. 40188 L. N., colored, male, married, age 46, was admitted to the hospital on January 24, 1947, with a stricture high in the cervical esophagus which followed the accidental swallowing of lye four weeks previously. Attempts at dilatation were unsuccessful, and on January 31, 1947, a gastrostomy was performed. He was discharged on February 8, and was readmitted on March 12, weighing 114 lbs. He was experiencing difficulty in maintaing adequate nutrition by gastrostomy feedings. On March 26, the cervical esophagus was exposed through an incision on the left side of the neck parallel to the anterior border of the sterno-cleido-mastoid muscle. The strictured area, measuring about one inch in length was incised longitudinally; a nasal tube was passed into the esophagus through the stricture, and into the stomach, where the distal end was brought out through the gastrostomy opening. A string was attached to the lower end of the nasal tube and was pulled through the strictured area and out of the mouth. The tube was then removed and a bougie was placed within the strictured area and anchored by a string attached to each end. The wound was closed in two layers over the bougie. Gentle traction on the string gave early motion to the bougie and prevented the formation of adhesions in the divided strictured area. The wound healed per primum, and the bougie was removed. It was not possible to continue dilatations during his stay in the hospital. He was discharged on May 2, 1947, with adequate esophageal lumen and had gained in weight from 114 to 145 lbs. He has been followed at intervals and the esophageal lumen continues adequate.

SUMMARY

1. The surgical treatment of achalasia of the esophagus is illustrated. Cases are reported.
2. The transthoracic approach for resection of high gastric lesions is advocated, with presentation of a successful case.

3. Sub-total esophagectomy with intra-thoracic esophago-gostrostomy is advocated for obstructive lesions of the esophagus in the upper, middle and lower thirds, with report of three cases. None of these presented any technical difficulties. Unfortunately, two did not survive. One of these was perhaps too young for so formidable an undertaking. The other was probably more debilitated than was appreciated.

   Regardless of the mortality in this small series, we prefer this method since larger groups are being reported with much lower death rates.

4. A lye stricture of the high cervical esophagus is reported which was successfully treated by external longitudinal division of the stricture and reconstruction of the lumen over a bougie.

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DISCUSSION.—DR. ALTON OCHSNER, New Orleans: Dr. R. Mason has shown us beautifully what can be accomplished in otherwise intractable lesions of the esophagus. With the introduction of antibiotics, it became possible to enter the chest and operate safely, which we could not do before. There are still, however, certain difficulties. One is the fact that these patients who are chronically ill, suffering either from neoplasms or infection, are likely to have contracted blood volumes, and unless the blood volume deficiency is determined and corrected, they are not able to withstand an operation of any magnitude. The ordinary blood determinations, such as the red cell count and hemoglobin determination, are not sufficient in these patients to determine whether or not anemia is present. Unless the blood volume deficiency is corrected, not only is shock likely to occur during the operative procedure, but also healing is interfered with.

Another difficulty in esophageal surgery is the incidence of stricture at the esophageal-gastric anastomosis. Dr. DeBakey and I have suggested a modification of the usually employed technic, which consists of a longitudinal incision in the esophagus, extending from the open end, thus increasing the esophageal opening. In this way the size of the opening can be greatly increased. Since we have been using this we have had no cases of stricture.

My further discussion will be limited to the organic strictures of the upper end of the esophagus. The first was in a patient aged 32 who swallowed lye at the age of two. As shown in the slide, a stricture is present in the upper portion of the thoracic esophagus in the region of the arch of the aorta. Esophageal dilation was not possible except under esophagoscopy. In order to cure this patient it was necessary to remove all the thoracic esophagus and reestablish the continuity of the digestive tract by bringing the stomach up and anastomosing it to the esophagus at the pleural apex. The next patient was one with a carcinoma of the esophagus involving the upper third of the thoracic portion which required resection of the entire esophagus, mobilization of the esophagus from behind the arch of the aorta, and anastomosing between the upper end of the esophagus and the stomach. The procedure in both these patients was tolerated well and the patients have made uneventful recoveries. These were possible, we believe, because of reestablishment of the blood volume and the use of appropriate technical procedures.

DR. J. E. DAILEY, Houston, Texas: It is with gratitude for the opportunity, and also with some trepidation, that I venture to discuss this paper. I only wish Dr. Mason had had the time to go into the postoperative care of these cases more fully. I think this is most important. In the past two years we have had the opportunity to perform twelve of these operations, that is, esophagectomies and partial resections of the stomach with anastomosis. I would like to mention three points of interest in postoperative management of these cases. In the first place, since it is generally believed that the use

of concentrated saline solutions intravenously has the tendency to concentrate salt in the region of the trauma with resulting edema, we have felt hesitant about using saline postoperatively and during operation, thinking that such edema at the site of anastomosis might interfere with healing. The second point is that we do not make it a policy to use a Levine tube routinely. In only two cases we had difficulty with stomach dilation postoperatively, probably due to section of the vagi, and we had to use a tube. And third, we have felt that since these patients produce and swallow their own saliva, there was no necessity for withholding liquids postoperatively. So we have permitted them to have water by mouth, one ounce each hour immediately, and on the second postoperative day have added a liquid formula diet and then increased it to a soft diet by the end of a week.

DR. C. FRANK CHUNN, Tampa, Florida: I want to congratulate Dr. Mason on his work, his excellent results and his presentation.

Achalasia of the esophagus, in the great majority of cases, is successfully treated by one or more courses of dilation of the esophagus. However, in from 2 to 5 per cent of cases, surgical reconstruction of an esophageal lumen is necessary.

With the concept that present day methods of anesthesia, chemotherapy and blood transfusion probably render thorocotomy as safe as laparotomy, I would like to show a few slides of the trans-thoracic resection of the lesion of esophageal achalasia with a thoracic esophago-gastrostomy.

Slide No. 1 shows the barium swallow shadowgram of a 55 year old white man whose dysphagia began in 1918. Multiple courses of esophageal dilation were of only temporary benefit. Since 1930 he had been unable to swallow anything except liquids, and even liquids became progressively more difficult. When seen in December, 1946, he had been unable to swallow even water for three days. X-rays and esophagoscopic examination indicated achalasia of the esophagus.

Slide No. 2. After appropriate preoperative preparation, a transthoracic resection of the esophageal lesion was carried out. The stomach was mobilized, the cardia was placed into the pleural cavity and the anastomosis of the esophagus to the cardia of the stomach was done. This was accomplished by using no clamps on the esophagus and having absolutely no tension on the anastomosis. The patient was out of bed in three days and went home in eleven days.

Slide No. 3. This shows the barium swallow two months postoperative, showing a very adequate anastomosis and stomach filling. He has eaten a normal diet without difficulty since soon after discharge from the hospital.

In dealing with lye strictures of the esophagus, especially since the great majority of these patients are children (however, we have treated our adult patients in the same way) we prefer to construct a whitzel gastrostomy with the serous membrane lined tube of the gastrostomy pointing at the esophageal opening. Then by placing and maintaining a silk string through the nose, stomach, and out through the gastrostomy, we have successfully dilated all our esophageal strictures. The dilations are done in the retrograde direction by pulling increasingly large rubber bougies through the gastrostomy and esophagus. The patient swallows liquids in a day or two, takes a soft diet in a few days and, a little later, a normal diet. Weekly retrograde esophageal dilations are done until the esophagus is fully dilated, and the dilation remains. This requires between one and two years.

In our hands this method has been very satisfactory. We have been able to dilate all our cases of lye stricture of the esophagus without mortality.

Again I would like to congratulate Dr. Mason on this excellent work.

DR. EDGAR W. DAVIS, Washington, D. C.: As a visitor I greatly appreciate the privilege of the floor to discuss Dr. Mason's paper. I congratulate him on his presentation. He has shown us that surgery of the esophagus has already passed the experimental stage and has now been added to our list of acceptable surgical procedures. This field of surgery has made tremendous strides in the last few years. To emphasize this progress,

I would like to say that it has now been a little less than three years since I attended a meeting in one of our large cities. The speaker on that occasion was introduced as being a man who knew more about cardiospasm than anyone in the world. In the speaker's discussion on carcinoma of the esophagus, he stated that surgery for carcinoma of the esophagus was nothing short of euthanasia. I am sure that speaker does not maintain that idea today. We, as surgeons, realize the clinical significance of the various obstructive lesions of the esophagus, and are anxious to try to do something for these unfortunate patients, but it seems that many medical men are still reluctant to refer these patients for surgery. For this reason I feel Dr. Mason's paper would be of even greater importance if presented to a mixed group of physicians than to a group consisting of surgeons only. I would emphasize the importance of esophagoscopic examination for any patient who has difficulty in swallowing, as the diagnosis will be made much earlier and the outcome will be much more favorable. It is relatively common for patients to be referred to us with a diagnosis of cardiospasm, who have been treated for months with belladonna, atropin or other antispasmodics. This line of treatment should be strongly condemned, and more appropriate diagnostic methods should be used earlier.

I cannot agree with one of the discussors who resected a short segment of esophagus and did an esophagogastrostomy for cardiospasm. The majority of cardiospasms can be carried successfully through life by careful and adequate dilation. If, however, dilation is not successful, a transthoracic or abdominal esophagogastrostomy without resection is the procedure of choice, because the operation is much less formidable, the end results are better and the mortality rate is much lower. This same procedure has been used also with gratifying results in a benign stricture of the lower end of the esophagus which resisted all forms of dilation.

If I may diverge for a moment from the discussion on obstructive lesions of the esophagus, I might say that I was greatly impressed by the number of patients who died from postoperative pulmonary complications after gastric resection, as presented in the previous papers. These postoperative deaths from pulmonary complications were designated as deaths from pneumonia. I seriously doubt that there is any such thing as postoperative pneumonia developing within the first two to five days following an operation. In my opinion, practically all these cases begin as a postoperative atelectasis and, if unrecognized and not properly handled, may of course develop a superimposed infection which then may be designated as pneumonia. The importance of proper postoperative care for these patients cannot be overemphasized. Accumulation of pleural fluid, unless of small amount, demands thoracentesis. Postoperative atelectasis demands bronchoscopic aspiration if the obstructing plug of mucus in the bronchus cannot be removed promptly by other means.

In connection with carcinoma of the lower end of the esophagus or the upper part of the stomach, when the obstruction is complete, although the lesion may be unresectable, an anastomosis of the stomach with the esophagus above the obstruction has furnished relief for a short time to one of our patients.

Dr. James M. Mason III, Birmingham, Ala. (closing): Of course blood replacement, as Dr. Ochsner emphasized, makes radical surgery possible. This is absolutely essential. Referring to Dr. Dailey's discussion of postoperative treatment, Dr. Davis pointed out that the most important step is prompt and complete re-expansion of the lung.

Whenever discussion of the use of the nasal tube for gastric suction is brought up, I refer to a paper Dr. A. O. Singleton presented before the American Surgical Association in 1942. We feel very strongly in favor of its use. Many children with lye strictures are treated successfully with dilations. Radical surgery is applied to those in which dilations are unsuccessful.

In the treatment of achalasia we prefer the transabdominal approach. The esophagus can be quite adequately mobilized from below the diaphragm, and this approach obviates the necessity of opening the pleural cavity.

PRELIMINARY REPORT ON THE USE OF TANTALUM MESH IN THE REPAIR OF VENTRAL HERNIAS*

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THE REPAIR of very large ventral hernias has always taxed the ingenuity of the surgeon. This is true not only when the defect is large, but also when the fascial structures surrounding a smaller defect are weak. A large proportion of these cases occur in very obese people. In such people the fascia surrounding the defect is often weakened by the infiltration of fat, and this militates against a successful repair by any of the ordinary methods. Fascial flaps of various sorts from the local site have been used to repair the defect. Free autogenous transplants of fascia lata have also been used. Years ago the present writer[1] introduced the use of large sheets of ox fascia lata for the repair of such defects. All of these methods have been more or less successful, but none has been uniformly so, especially in the type of case dealt with in this paper.

On March 20, 1946 when my attention was called to tantalum mesh by one of our leading surgical supply houses,† I welcomed the opportunity to try it out, both experimentally and clinically. The material had already been used on a limited number of cases by C. R. Lam,[2] of the Henry Ford Hospital, and by T. D. Throckmorton,[3] of Des Moines. I, also, have now used the material in a limited number of cases both experimentally and clinically. It has not been used more widely because the supply has been very limited; for a period of time the material was not procurable at all. Recent information indicates that it is now available on the open market.

Metal filigrees, such as silver, were introduced for hernia repair many years ago, and this method has recently been reviewed by Cole.[4] So far as I know, however, nothing similar to a screen mesh has been used before the introduction of tantalum mesh.

I have used tantalum mesh experimentally in four dogs. In each instance three to six inches of the rectus muscle on each side was resected, and the defect immediately repaired by suturing a piece of tantalum gauze to the edges of the fascia surrounding the defect, there being nothing left between the peritoneum and the subcutaneous tissue but the tantalum gauze. These animals were sacrificed from 4½ to 9½ months after operation. In each instance the defect was completely closed by the mesh, which had become

*Read before the Southern Surgical Association at Hollywood Beach, Florida, December 11, 1947.

† My attention was first directed to tantalum gauze by Dr. Herbert L. Davis, Director of the Department of Experimental Research for the Ethicon Suture Laboratories, of Johnson & Johnson, New Brunswick, New Jersey. During the course of some correspondence with Dr. Davis, with regard to changing the solution in which ox fascia is preserved, he stated that he had been interested in the possibilities of tantalum gauze for the repair of hernias and asked if I would like to try it out. Johnson & Johnson furnished all the materials (tantalum mesh and tantalum wire) used for the experiments in this paper.

covered by a thick and tough envelope of fibrous tissue. The fibrous tissue had grown through the meshes of the gauze throughout, and could not be separated from it except by very sharp dissection (Fig. 1). A firmer and more thorough-going closure of the defect can scarcely be imagined.

FIG. 1. Piece of tantalum gauze removed from a dog 9½ months after operation. The meshes of the gauze have been thoroughly infiltrated with fibrous tissue and the entire piece of gauze is covered with a tough envelope of fibrous tissue.

The material has now been used clinically in five cases. All of these cases were very fat people who had very large hernias and poor tissues to deal with. The first case was a private patient operated upon at the Union Memorial Hospital. Three cases were ward patients from my service at the Sinai Hospital. One patient was operated upon on the service of Dr. Howard Kern at the Sinai Hospital, and he has kindly consented to allow me to include it in the series. In Case 4 of the series (Figs. 2, 3, 4 and 5), it was impossible to close the large defect, and a piece of tantalum gauze was sutured to the edges of the defect, overlapping the edges somewhat, and leaving only the gauze between the peritoneum and the subcutaneous tissue, just as in the experimental animals. In the other cases it was possible barely to approximate the edges of the defect, and it was certain that the repair would not have held with this simple approximation. In these cases the suture line was reinforced by suturing a piece of tantalum mesh over it, well overlapping the surrounding weak fascia. In one case (Case 5), after a simple approximation of the edges of the defect, the tissues were under so much tension that the rectus sheath was split longitudinally on each side of the suture line to relieve tension, and then the suture line, and also the incisions in the rectus sheath, were covered by tantalum mesh.

The technic of using this material is shown in Figure 6. The mesh is held

FIG. 2.—Front view of Case 4 before operation.

FIG. 3.—Side view of Case 4 before operation.

FIG. 4.—Front view of Case 4 two weeks after operation.

FIG. 5.—Side view of Case 4 two weeks after operation.

in place with interrupted sutures of tantalum wire. Before placing the sutures, about ¼ inch of the edge of the mesh is turned over on itself, so that the sutures go through two thicknesses of the mesh. This makes the sutured edge stronger, and prevents the wire suture from pulling out of the mesh. The material is pliable and easy to handle. It can easily be cut with ordinary surgical scissors. Braided tantalum wire is now available on atraumatic needles, which makes the suturing of the mesh in place a much easier procedure. The braided wire is as easy to handle as silk or catgut.

The first of the patients here reported was operated upon 18 months ago,

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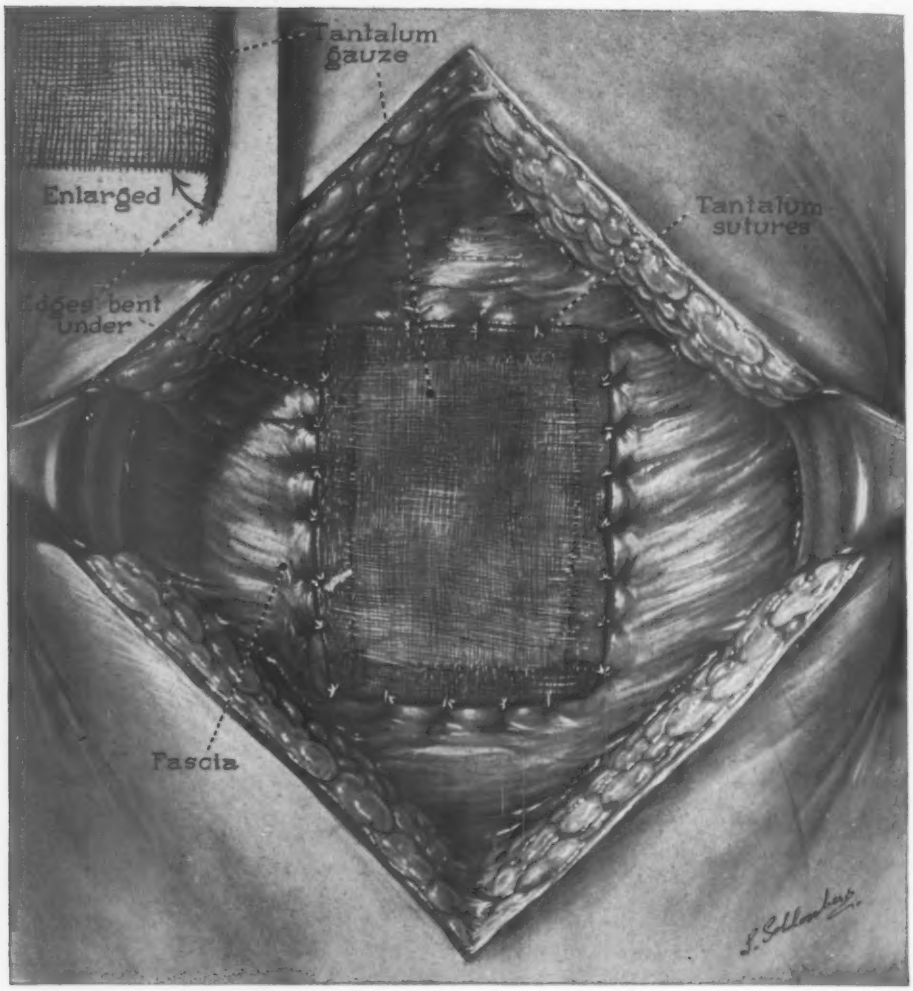

FIG. 6.—Technic of suturing tantalum mesh in place.

and the most recent one only 2 months ago. All of these patients have recently been examined personally by me, and all so far show excellent results. Also, all of them are delighted with the excellent results obtained, so far as their personal comfort is concerned. We often overlook the fact that these patients suffer a great deal of discomfort, not only from the feeling of insecurity occasioned by the defect in the abdominal wall and the dragging down sensation associated with it, but also from nausea and other disagreeable symptoms. The second patient in the present series was so miserable that he had contemplated suicide, because a previous attempt to cure his hernia had been unsuccessful, and he felt that there was no relief from his discomfort. Life is now again a pleasure for him. The first patient in the series had had two unsuccessful attempts to repair her hernia, and she is equally delighted with the outcome.

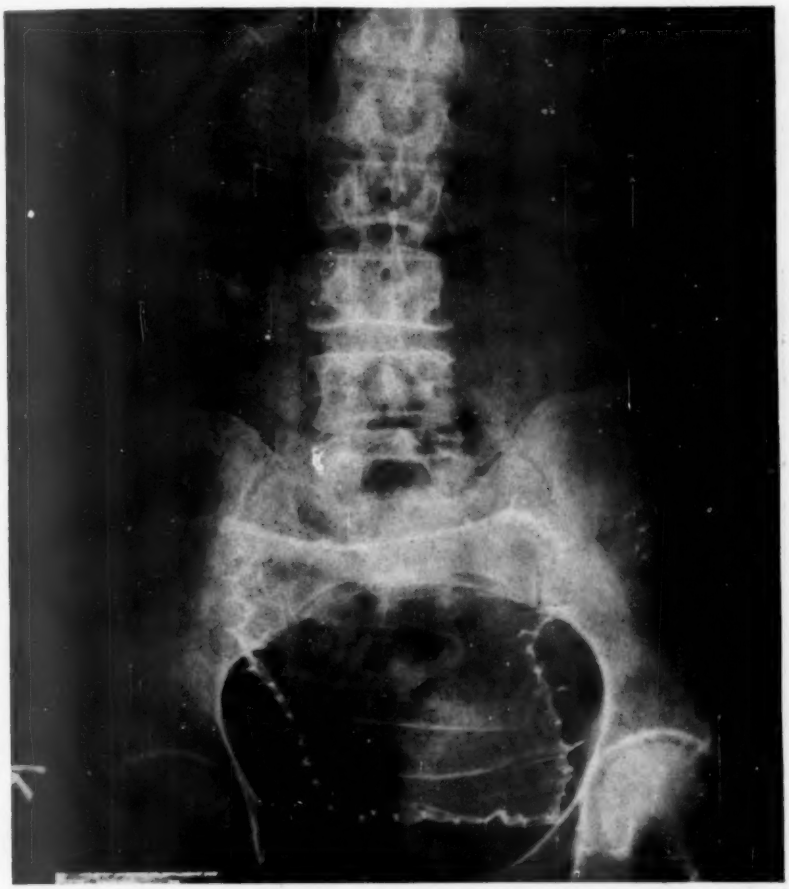

FIG. 7—X-ray of Case 5 five weeks after operation, showing the implanted piece of tantalum gauze to be intact.

The appearance of the tantalum gauze by x-ray has been studied in two cases. Figures 7 and 8 show the x-rays of these two cases (Cases 2 and 5), one taken five weeks after the operation and the other 11 months after operation. It will be noted that in the case recently operated upon (Case 5—Fig. 7), the mesh is intact, while in that operated upon 11 months prior to x-ray (Case 2—Fig. 8) there is a good deal of fragmentation of the mesh. This fragmentation, which occurred in the second case (discussed in the preceding paragraph), has not in any way interfered with the strength of the repair. The patients, in general, are unaware of the presence of the mesh. The strength of the repair is not due to the mesh itself, but to the fibrous tissues built up through and around it, which form a very strong abdominal wall.

I have often wondered what another surgeon, subsequently doing a laparotomy on one of these patients, would think when he had encountered wire screening in the belly wall of his patient. It might be wise for the patient to tell any subsequent surgeon about the type of hernia repair he had had. The

material, however, would offer no real obstacle to a subsequent laparotomy, as it is readily cut through with scissors.

COMMENT

The early results with the use of this material, both experimentally and clinically, are such as to fill this writer with enthusiasm. There have been no untoward side effects in any of the cases, except that in the first case

FIG. 8.—X-ray of Case 2 eleven months after operation. Note the partial fragmentation of the tantalum mesh.

operated upon there was a collection of sterile fluid in the lower end of the wound. This was aspirated and did not recur. None of the other cases had it. I believe that the collection of fluid was probably due to a dead space left at the time of operation. This should be avoided. There have been no infections in this small series, and there has been no untoward tissue reaction, either experimentally or clinically.

In operating on these cases, the tantalum mesh should be covered by skin that has enough subcutaneous tissue under it to prevent the palpation of the

mesh through the skin. Very often the subcutaneous tissue is very much thinned out over the hernia, and in places is entirely absent, the peritoneun being adherent to the skin itself. In these cases, however, there is generally enough redundant skin to permit resection back to skin that has underlying cutaneous tissue. If necessary, flaps can be mobilized by undercutting, and brought together over the implanted tantalum mesh.

CONCLUSION

A limited experience with the use of tantalum mesh in the repair of large and difficult ventral hernias leads to the belief that it will prove a most valuable material in the cure of this difficult condition.

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DISCUSSION.—DR. J. M. T. FINNEY, JR., Baltimore: I cannot let this go by without giving a personal word of thanks to Amos Koontz for his interest in this problem of bad herniae. His experimental work in the healing of tissues after operative repair is classic. As you all know, he has been interested for many years in repair of difficult herniae, and anyone who does surgery knows such repair can be most difficult, particularly if there have been three or four previous operations to mess things up. He gave us preserved fascia and now this mesh. The coordinating clinical work is something for which we all, as operating surgeons, should be eternally grateful. I have not used the mesh yet, but if I run into any problems like those he showed on the screen, I shall certainly be glad to have him tell me how to handle them.

DR. WILLIAM H. PRIOLEAU, Charleston, S. C.: With Dr. Finney, I would like to commend Dr. Koontz for his continued pioneer work in this field. It appears that the use of tantalum mesh will prove to be a solution in the repair of a large number of ventral herniae. We are familiar with the value of alloy steel wire in the closure of grossly contaminated and even infected abdominal incisions. In such cases the wire is well tolerated by the tissues. It is seldom extruded or causes a persistency of the infection with sinus formation, as is so commonly the case with silk and cotton. It would be of interest and utmost importance to know how tantalum mesh would behave under such conditions. Would it be tolerated and serve as an effective support to the wound, or would it have to be removed? If well tolerated in the presence of infection and contamination, its field of usefulness will be greatly increased.

DR. AMOS R. KOONTZ, Baltimore (closing): I want to thank both Dr. Finney and Dr. Prioleau for their discussions, and also Dr. Prioleau for his suggestion with regard to trying out tantalum gauze in infected areas. I shall certainly follow through on this when I get back.

PERINEAL HERNIA*

Report of a Case Occurring in a Male

THOMAS HARROLD
MACON, GA.

EXCEPT FOR THE COMMONPLACE CYSTOCELE and rectocele and the less common enterocele which are seen in women following the trauma of childbirth, hernia through the pelvic floor in either sex is quite rare and excessively rare in the male. I wish to report a spontaneous levator or perineal hernia occurring in a man with no history of trauma.

In 1922 Chase[1] suggested the name of levator hernia and offered a simple classification of these herniae:

Levator Hernia.
1. Congenital.
   a. Pudendal.
   b. Perineal.
   c. Mixed.
2. Acquired.
   a. Pudendal.
   b. Perineal.
   c. Mixed.

Yeomans[2, 3] and others have called attention to the weak spot in the perineal floor at the point of junction of the iliococcygeus and the pubococcygeus muscles. It is thought that most levator herniae break through at this point, although they may occur through any portion of the levator muscle. Having passed through the levator muscle, further descent must be either anterior or posterior to the transversus perinei muscle and thence into the subcutaneous tissue of the vulva or perineum. The anterior space in the male is filled quite solidly with the prostate and is not subjected to the various injuries and accidents of childbirth, therefore anterior levator or pudendal hernia is rare in the male and some authors state that it does not occur. The most vulnerable spot in the male perineum is posterior to the transversus muscle in the pararectal or ischio-rectal region where, even in the normal perineum, there is a surprisingly strong impulse on coughing.

Pudendal hernia is very difficult to repair but several successful cases are reported.

Considering the degree of trauma involved, perineal hernia following abdomino-perineal resection of the recto-sigmoid is surprisingly rare and constitutes a special group not considered in this paper.

In 1918 Moschowitz[4] reported a case of perineal hernia and collected a total of 28 cases, some of doubtful authenticity, in a review of the world literature prior to that time. Only 3 cases in males were found. 1. Thomas in 1897 reported a perineal hernia which appeared suddenly in a man, aged 62,

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Thursday, December 11, 1947.

while he was lifting a heavy weight. It was quite large and only partially reducible. At operation a large fibromyoma was removed and the hernia successfully repaired. 2. Harrison in 1866 reported a strangulated perineal hernia in a male. The hernia was incised and a loop of gangrenous bowel was extruded spontaneously. The patient recovered but no statement is made as to the cure of the hernia. 3. Stiegele in 1869 reported the reduction of a

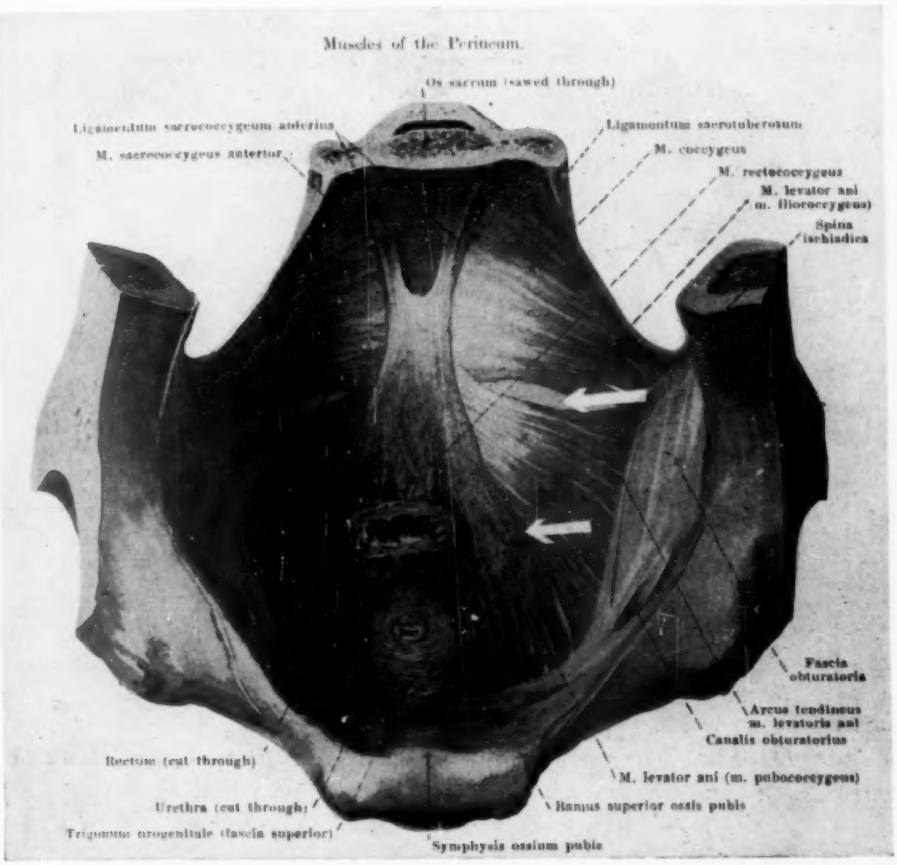

FIG. 1. LEVATOR ANI MUSCLES VIEWED FROM ABOVE (Spalteholz)
The arrows show the points of exit of levator herniae. The lower arrow shows the point of fusion of the ileococcygeal and pubococcygeal portions of the levator muscle. When this fusion is incomplete, a weak area in the pelvic floor is present and perineal hernia in the male or pudendal hernia in the female may result.

strangulated perineal hernia in a man aged 73. Moschowitz's own case was a girl, aged 2½ years, who had a swelling of the buttock of six weeks duration. The mass presented between the ischium and anus and increased in size when the child cried. It was globular and firm. Through a para-rectal incision, a long fibroma attached to the perinoteum was removed. The peritoneum had been pulled down by the tumor through a defect in the posterior portion of the levator muscle. The wound was closed in layers and the patient was apparently well two years later.

Matheson[5] in 1943 reported a case of sarcoma originating in the pelvis which extended through the pelvic floor and presented in the perineum. There was an impulse on coughing and other signs simulating perineal hernia. He refers to a similar case of myxoma presenting in the perineum and reported by McGavin. Strange[6] in 1935 reported a large perineal hernia in a man aged 64 which followed severe trauma at the age of 16. No attempt

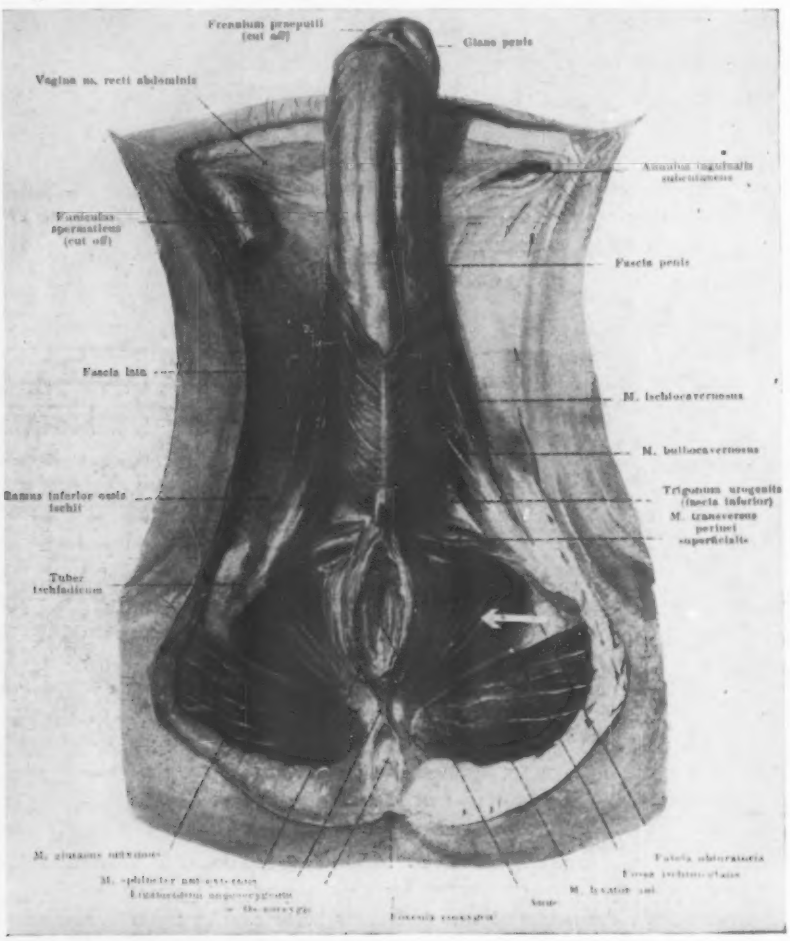

FIG. 2. MUSCLES OF THE MALE PERINEUM (Spalteholz)

The arrow shows the point of emergence of perineal hernia in the male posterior to the transversus perinei muscle. Note how the space anterior to this muscle is filled by prostate and bulbus cavernosus of the penis thereby preventing pudendal hernia.

at repair was made. Roentgen-ray did not reveal bowel in the sac. There was typical impulse on coughing.

Treatment of pudendal and perineal hernia has always been most difficult and unsatisfactory. Successful repair done through the perineum and also through the abdominal approach has been reported. Pudendal herniae have usually required a combined approach done in one or more stages, with some

type of obliteration of the cul-de-sac above and repair of the muscular and fascial layers below. Perineal herniae are usually repaired through the perineal approach by simple excision of the sac and repair of the disrupted muscle and fascia. No group of cases large enough to be statistically significant has come to my attention, but one gets the impression that approximately 50% are repaired successfully. The prognosis depends upon the strength of the muscle and fascia available for repair.

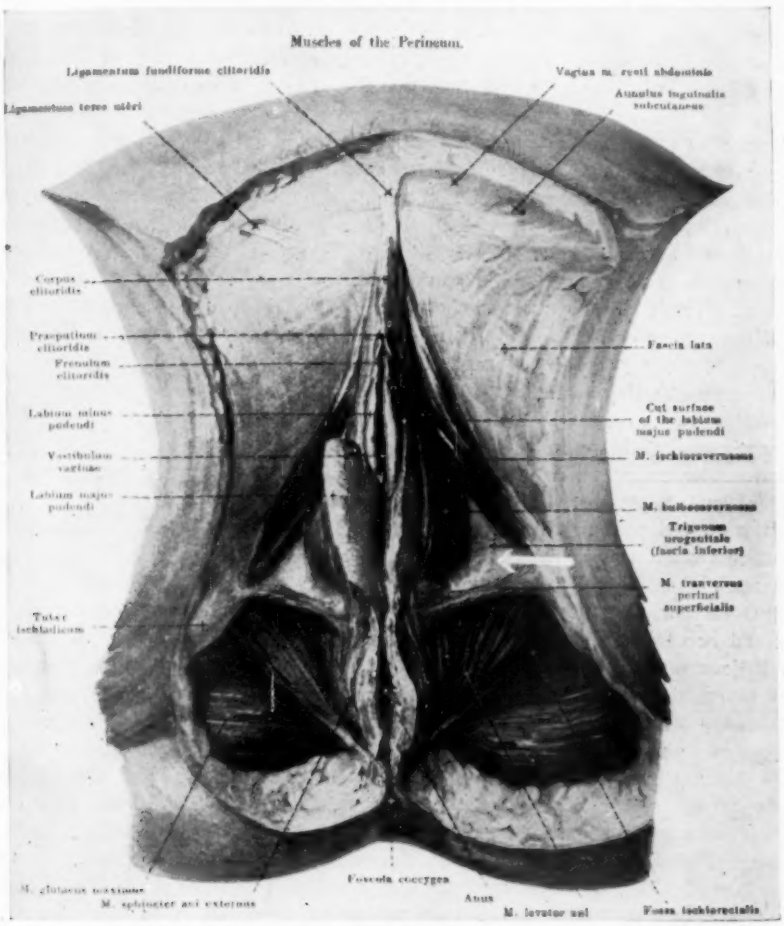

FIG. 3.—MUSCLES OF THE FEMALE PERINEUM (Spalteholz)

The arrow shows the point of emergence of pudendal hernia in the female. Note how much larger the space anterior to the transversus perinei muscle is in the female than in the male. This area is subjected to trauma during childbirth which also makes pudendal hernia more frequent in the female.

CASE REPORT

The patient is a white man, aged 46. Occupation, collector. He was first seen by me September 5, 1947, complaining of a painful swelling to the left of the rectum.

Past history.—Appendectomy for acute appendicitis in 1946. In June and July of 1947 he had been given several injection treatments for hemorrhoids because of dis-

comfort in the region of the rectum. The discomfort was not relieved by the treatment. The patient has always been of a nervous temperament but has had no serious illnesses or accidents. His occupation of collecting installment accounts consists of calling from house to house and being in and out of an automobile and walking all day.

Present illness.—The patient could not date the onset of his present disability accurately, but for about a year he had noticed a vague discomfort in the region of the rectum and for several months he had thought that there was a swelling to the left of the rectum. He stated that this swelling was not present all of the time, and that other doctors who had examined him had not found it. The discomfort gradually increased over a period of months and recently he has been carrying a soft cushion to church and other places where he expected to sit for any length of time. He developed a chronic low backache with some pain going down his legs. Recently he has been unable to do a full day's work and frequently has to go home and rest. There has been no fever and no abscess in this region.

Physical examiation.—The patient is a rather small, slightly built man who appeared to be rather highstrung and worried. His general physical examination was essentially negative except for the perineal region. When standing, there was a noticeable asymmetry of the buttocks with obvious fullness in the region of the left ischial tuberosity. This swelling disappeared almost completely when he lay down. There was no inflammation and no tenderness on palpation but manipulation of the swollen area caused moderate discomfort. There was a marked hernial impulse on coughing when standing or lying. No gurgling or gas was present. The hernial mass was soft and easily reducible. The mass apparently descended quite close to the lateral rectal wall, and a slight impulse on coughing could be felt through the rectal wall.

Roentgen-ray examination with barium given by mouth and by enema failed to show any intestinal loops in the left ischio-rectal space.

Cystoscopic examination showed no abnormality of the lower urinary tract.

Operation.—September 18, 1947. Pentothal anesthesia. With the patient in Sims' position, a curved para-rectal incision over the left ischial tuberosity and buttock was made. The rectum was retracted medially. The ischio-rectal space was occupied by a fibrous mass about 3 x 8 centimeters in size. This mass was quite soft and cellular and, upon further dissection, was found to be firmly attached to the peritoneum. This mass could be easily displaced upward retroperitoneally into the hollow of the sacrum. When it descended into the ischio-rectal fossa, it pulled down with it a hernial pouch of peritoneum about 1.5 x 5 centimeters in size. This hernial mass emerged from the pelvis through a defect in the posterior portion of the levator muscle which was greatly attenuated and scarcely recognizable as such.

The fibromatous mass was enucleated without difficulty and was excised together with the hernial sac. The neck of the sac was closed at a high level with mattress sutures of atraumatic chromic catgut. The defects in the levator muscle and pelvic fascia were closed without tension with chromatic catgut. These tissues were of poor quality. Use of a flap of gluteus muscle was considered but not used. The wound was closed with only one small Penrose drain which was removed in 24 hours.

The pathologist reported the fibrous mass to be a "fibrous hemangioma."

The postoperative course was uneventful. The wound healed per primum and now, two months later, there is no evidence of recurrence.

COMMENT

Aside from the rarity of a perineal hernia in a male, one other point seems to be of more than passing interest. In five out of eight cases of perineal herniae (six male cases collected from the literature, my own case and one case in a girl aged 2½ years) a tumor was present in the hernial mass. In one instance the tumor was malignant, in the other four it was benign. In

these cases in which tumors were present no loops of bowel were found in the hernial masses. Therefore, it seems likely that in approximately one-half of all true perineal herniae a retroperitoneal tumor is present and forms the wedge which penetrates the pelvic floor and incidentally drags the peritoneum down with it.

SUMMARY

A case of spontaneous perineal hernia in a man, complicated by a benign retroperitoneal fibrous hemangioma, with repair of the hernia, is reported.

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DR. T. C. DAVISON, Atlanta, Ga.: I have never seen such a case as Dr. Harrold has described, but in looking at the picture he has shown I can realize the possibilities. It reminds me of a story I heard many years ago: A young doctor having located in a small community was called to see a prominent citizen who had a strangulated hernia, and he advised immediate operation. There was a much older doctor in the community in whom everyone had a great deal of confidence, and the patient's family insisted upon having him in consultation. When the elderly doctor arrived and examined the patient, he said—"I have seen many such cases; it is nothing but a wind cyst and when you stick a knife into it you get nothing but wind and feces, and they all die."

NOTICE

The following statement is published at the request of Dr. Donald E. Barker whose article on "New Donor Areas in Skin Grafting" appeared in the March issue of the ANNALS OF SURGERY:

"The Dermatome shown in the March issue of the ANNALS OF SURGERY, under the heading of "New Donor Areas in Skin Grafting, is an experimental model, manufactured with the permission of Mr. George Hood, owner of the patent on the Padgett-Hood Dermatome. Anyone desiring to purchase a Dermatome should contact the Kansas City Assemblage Company, Kansas City, Missouri, who are the sole manufacturers of the Padgett-Hood Dermatome."

THE MANAGEMENT OF PENETRATING ABDOMINAL INJURIES*

Comparative Military and Civilian Experiences

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HISTORICAL NOTE

THE EARLIEST REFERENCE in the literature to an abdominal wound is apparently in the Anabasis,[1] in which Xenophon described the plight of a Greek army captain who returned to his camp literally holding his bowels in his hands after an eviscerating wound of the abdomen. It was not until 1853, however, during the Crimean War, that any form of surgical intervention was recommended for such injuries. Then Baudens[2] suggested that in suspected internal injuries a small abdominal incision should be made, through which a sponge could be introduced; if the sponge returned bloody, the abdomen could be opened and the bleeding vessel ligated.

During the War between the States many surgeons on both sides spoke in favor of surgical intervention for abdominal injuries, but no one, so far as is known, acted on the advice. Available records, including one series of 3,690 cases,[3] indicate that in that war the mortality of this type of injury was 90 per cent and more. In the years following the war civilian surgeons also advocated operation for abdominal injuries, but actually surgery did not then have a great deal to offer. The lack of a satisfactory anesthetic agent and the hazards of all surgery in the pre-Listerian era meant that the patient who was not operated on had about as good a chance of recovery as the patient submitted to surgery. The popular method of treatment therefore continued to be rest, starvation, and the administration of morphine.

After 1880 the voices favoring active intervention in abdominal injuries became louder. Surgical and anesthetic technics, while still crude by present-day standards, had so far advanced that laparotomy was not infrequently undertaken for abdominal and pelvic tumors, and there seemed no good reason why the same procedure should not be followed for the investigation and repair of visceral damage. The death of President Garfield September 19, 1881, from a pistol wound of the abdomen, did much to stimulate interest in active treatment for penetrating abdominal wounds, and the consensus of medical opinion was that he could have been saved by active surgical intervention.

In 1882 J. Marion Sims[4] wrote: ". . . there is no more danger of a man's dying of a gunshot or other wound of the peritoneal cavity, properly treated, than there is of a woman dying of an ovariotomy, properly performed."

By 1887 Parkes[5] was able to write: ". . . there are few modern surgeons, who, when confronted with a bullet wound of the abdominal walls . . . would explore the cavity. One is almost tempted to say that all cases are entitled to

* Read before the Southern Surgical Association at Hollywood Beach, Florida, Thursday, December 11, 1947.

the chance of life offered through operative procedure. . . . However, if the abdominal wound is complicated or severe . . . or so great a time has elapsed as to allow . . . virulent inflammation, the probability is that the issue will be fatal."

Thereafter surgical intervention was accepted as the better form of treatment. Many surgeons began to operate for abdominal injuries, and the results were frequently encouraging. Coley in 1891[6] reported a mortality of 67 per cent in a series of 165 abdominal injuries and Fenner in 1901,[7] in reporting a mortality of 59 per cent in 152 penetrating abdominal wounds, remarked, ". . . despite the high mortality, I still think the indication for operation is pretty generally accepted the world over."

These results, indeed, compared favorably with the mortality of 81 per cent in the 4,958 collected cases reported by Stimson in 1889,[8] in all of which nonsurgical measures had been employed, and with the mortality of 90 per cent for abdominal injuries in the Spanish-American War. In the Boer War, at the turn of the century, the results were not much better, but there were certain reasons why surgeons could not then resort to operation. Distances were great. The heat was a serious problem. The supply of water was limited and usually contaminated. Transportation was slow and difficult. All of these factors were so serious in themselves, or so prolonged the time interval, that operation under the circumstances offered little more hope for recovery than did expectant treatment.

The point of view concerning abdominal injuries which prevailed during the South African War also prevailed early in World War I. It was not considered practical, under conditions of war, to set up field hospitals close enough to the line of battle to receive patients within the time interval required for successful abdominal surgery. This reasoning must be evaluated before it is condemned in light of the fact that many ambulances were still horse-drawn and that the motorization of vehicles of war was in its infancy. Moreover, the military authorities were severely objective in their planning: A battle casualty with an abdominal wound was regarded as having almost as little chance of survival as if he had been killed instantly, and the effort and equipment necessary to save the few who might survive were not considered justified.

Makins,[9] who led the group of military surgeons committed to the policy of nonintervention in abdominal injuries, expressed the viewpoint of all military surgeons when he said ". . . small gut lesions were practically always fatal, and . . . the success obtained by the 'wait and see' policy was due to the escape of the bowel, although the belly had been penetrated."

The policy of expectant treatment for abdominal injuries did not, however, remain entirely unchallenged in World War I. An occasional civilian surgeon, newly in uniform, insisted upon prompt surgical intervention. The first operation for a penetrating wound of the abdomen in that war seems to have been done in December, 1914, by Captain John Campbell[10] of Liverpool, who

successfully repaired two perforating bullet wounds of the stomach. Three months later Captain Owen Richard[10] successfully resected 6 feet of ileum. Other surgeons advocated similar methods, and a gratifying, though small, reduction in mortality resulted. Wallace[11] reported 1,200 cases treated by surgery, with a mortality of 53.9 per cent, and Lockwood and Kennedy[12] reported 500 cases, with a mortality of 51.7 per cent.

In the decade following World War I the civilian statistics for penetrating abdominal injuries showed no significant improvement over earlier statistics. Mortalities of 48.2 per cent, 59.2 per cent, 61.4 per cent and 68 per cent were reported, respectively, by Billings and Walking,[13], McGowan,[14] Oberhelman, LeCount,[15] and Prey and Foster.[16] The mortality in the 1,299 cases reported by Loria[17] from Charity Hospital of Louisiana at New Orleans for the period 1901-1930 was 62.3 per cent.

Between 1930 and 1942, however, three highly significant developments exerted a profound effect on the management of abdominal injuries. 1. A better appreciation of the fundamental pathology and pathogenesis of shock made possible an accurate estimation of the degree, as well as the prompt application of effective treatment before irreversible changes occurred. 2. A fuller knowledge of the protein and electrolytic constituents of the body made possible the correction of deficits in these constituents at the same time that more obvious blood loss was corrected. 3. Effective chemotherapeutics and antibiotics were introduced and their employment was put upon a rational basis, with the result that infection, as manifested by peritonitis, cellulitis and pneumonia, was no longer an uncontrollable problem in the management of abdominal injuries.

Even with these new developments, however, the mortality of abdominal injuries in civilian practice, except for small series of selected cases reported by single surgeons, remained extremely high. Rippy[18] in 1941 reported 369 cases treated over a 17-year period, with a mortality of 60.5 per cent; a hopeful feature was that in the 29 cases treated in 1940 the mortality had been lowered to 41.3 per cent. In 1943 Hamilton and Duncan[19] reported 190 cases of gunshot wounds treated over a 10½-year period with a mortality of 51 per cent; in the cases in which surgery was done the mortality was 48.9 per cent. In the same year Elkin and Ward[3] reported 238 abdominal injuries with a mortality of 50.9 per cent. Two series of cases reported about this time from Harlem Hospital[20] showed a slight increase in mortality of the second series, from 59.3 to 62.6 per cent, but this experience, fortunately, was not indicative of the general trend.

PRINCIPLES OF MANAGEMENT OF WORLD WAR II

During the first years of World War II reports from British surgeons in the field showed no great improvement over World War I in the mortality of abdominal injuries, which remained in the neighborhood of 60 to 70[21] per cent. On the other hand, these statistics were far more accurate than the statistics of World War I, which usually did not take into account deaths

from shock and hemorrhage on the battlefield and which were actually somewhat higher than they seemed. In World War II the excellent system of evacuation resulted in the admission to field hospitals, and therefore to the benefits of surgery, of many men who in World War I would have died on the battlefield. There were also extenuating circumstances. As in the Boer War, transportation of the wounded over the desert areas of North Africa was difficult and hazardous, and the long supply lines, over which even water had to be brought, introduced difficulties that frequently were insuperable. To the credit of the surgeons who carried on under such tremendous handicaps it must be said that their results showed a progressive improvement and, as the war progressed, the surgical mortality for abdominal injuries in the North African Theater compared favorably with that of any other group.

By the time American Armies entered combat late in 1942, the management of abdominal injuries was fairly well standardized. It called for medical aid at the earliest possible moment, though first aid, it is true, was frequently limited merely to the administration of morphine, the application of sulfa crystals to the wound (a practice later discarded), and the application of sterile gauze pads. Whenever possible, plasma or whole blood was given before the patient reached the first medical installation.

The policy of surgery for abdominal injuries had become generally accepted by the time American Armies entered combat, and certain lessons concerning their management had also been learned. One was that while prompt operation was desirable, movement to installations in the rear, where surgery could be done, was necessarily slow under military conditions. The solution of this problem was the establishment of field hospitals far forward in the combat zone. These hospitals were equipped with surgical supplies and were staffed with competent surgical personnel, so that shock could be treated adequately and extensive surgical procedures of urgent character could be performed on any part of the body.

A second lesson which was learned early in the war was that casualties with abdominal injuries did not tolerate early transportation after operation. Field hospitals were therefore equipped and staffed to hold such patients for at least 10 days after surgery, and longer if necessary, and an important factor in the earlier mortality of abdominal injuries was thus practically eliminated.

A third lesson of the early days of the war was a realization of the importance of triage at the level of the clearing station. The choice of the right time for surgery on the right patient must be credited with a large portion of the salvage of casualties which distinguished World War II.

In contrast to earlier practice, no wounded soldier in World War II was ever denied the possible benefits of surgery because his condition was regarded as poor, or even as hopeless. If he could be brought to the operating room alive he was given whatever chance he might have. In general, this policy increased the surgical mortality, because in many instances such patients died on the operating table or within a few hours after operation. On the other

hand, the almost miraculous recoveries which sometimes occurred were full justification for it.

RESUSCITATION

The time interval between wounding and operation was kept at an astonishingly low level, the average being 10 to 12 hours, but the brief lapse was not regarded as the most important consideration in the management of abdominal injuries. Patients with active, massive hemorrhage were operated on as promptly as possible, but in the absence of such bleeding, time was deliberately taken to administer blood, plasma and electrolytes according to the indications of the special case. During this interval dirty battlefield clothing was removed, body heat was restored, sedatives were administered, and such diagnostic procedures were carried out as would determine accurately the location and extent of the abdominal injuries. The special shock teams responsible for resuscitation played a major role in the reduction of the mortality of abdominal injuries in World War II.

TECHNICAL CONSIDERATIONS

All the important technical points in the management of abdominal injuries have been described numerous times and need not be repeated in any detail. Operations were performed expeditiously according to a definite plan, which reduced the percentage of error and the working time to a minimum. Shock therapy was continued throughout the procedure and until all danger of hemorrhage and peritonitis had passed.

The management of wounds of the colon and rectum, however, provided one of the outstanding contributions of military surgery in World War II. The basic principles of therapy were (1) routine exteriorization of the traumatized bowel whenever it could be sufficiently mobilized to bring it outside of the abdomen, and (2), the subsequent use of the segment as a colostomy. When mobilization was not possible, proximal loop colostomy was employed. No attempt was ever made to repair simple perforations of the colon, and resection was regarded as preferable if the damage was extensive. Resection was the method of choice for the treatment of injuries of the right side of the colon, especially if the terminal ileum was also damaged.

Injuries of the extraperitoneal portion of the colon and of the rectum were never left untreated, no matter how inconsequential they might seem. Infected fistulas which followed improper treatment were particularly serious if the pelvic bones had been damaged; osteomyelitis was then an almost inevitable consequence. The lesson was finally learned that complete diversion of the fecal stream was essential in all injuries of these portions of the large bowel, and it was also found that this could be accomplished only by some method which separated the colonic stoma or which closed the opening in the distal loop, or by providing a second colostomy in the proximal (transverse) loop of colon.

Colostomy had been suggested as a method of treating injuries of the colon in World War I but seems not to have been used except in the most serious

cases. The result was that the method was in ill repute even before it had had a fair trial. In the interval between the wars, civilian surgeons frequently brought certain tumors of the bowel outside of the abdominal cavity and created a spur colostomy, which required crushing at a later date to reestablish continuity of the bowel. The same procedure was obviously adapted to military usage, and the military surgeons of World War II were in a receptive mood for it, in view of the extremely high mortality which other methods of treatment had previously accomplished. It is to the Surgical Consultant of the British Army, Sir H. G. Ogilvie,[22] that the chief credit is due for insisting upon routine exteriorization of the wounded colon with colostomy, as well as the use of colostomy for all injuries of the rectum and extraperitoneal colon. These methods were found highly effective in the treatment of casualties of the first air raids over England, and they were carried over into the North African and Mediterranean Theaters by the British military surgeons. American surgeons used the same methods without, however, knowledge of the British practice, from the time of the first landings in North Africa in November, 1942, and they were soon thereafter made the official practice.

Colostomies were usually closed in the general hospitals of the Zone of Interior. The operation was at first undertaken with a good deal of timidity, for military surgery is not civilian surgery and there was justifiable doubt as to how the stoma had been created, a doubt which the information on field medical cards did relatively little to dispel. At first spurs were crushed outside of the peritoneum, as in civilian practice, but the results were not good. Many times the spur was short and inadequate and sometimes it was non-existent. The application of a clamp or enterotome was therefore dangerous as well as painful. Moreover, rotation of the loops, sometimes for as much as 180°, was often noted, and mesentery and loops of intact bowel were often found interposed between the colostomy loops. Hemorrhage and necrosis of the bowel wall also occurred.

Extraperitoneal closure of a colostomy created under battle conditions was obviously not parallel to closure of a colostomy created under civilian conditions, but originally there was doubt as to the safety of the intraperitoneal technic. As experience accumulated, however, it became evident that this technic was considerably less dangerous than the more or bless blind extraperitoneal technic. Apparently the peritoneal cavity could be entered with impunity, probably because the peritoneal tissues had been vaccinated against infection by the reaction which occurred following injury. During the latter part of the war, therefore, it became routine to open the peritoneum widely, release adhesions, repair the bowel by an end-to-end or lateral anastomosis, and replace the colon into its normal position. The results were uniformly good. Complications were few, and the mortality in some series of cases was less than 0.5 per cent.

MORTALITY

The principal causes of death in abdominal injuries were shock, hemorrhage, peritonitis and pulmonary complications, in that order of frequency. As

Ogilvie[22] well expressed it, deaths which occurred in the first two hours after wounding were due to hemorrhage, in the first two days to shock, and in the first two weeks to infection. The majority of deaths occurred within 48 hours of wounding, and it was soon evident that patients who could not be brought into field hospitals within that period had very little chance of recovery. On the other hand, while the time factor was important, the so-called multiplicity factor was found to be even more important: A patient's chance of survival depended upon the number of organs injured, the mortality rising progressively as the number of injured viscera increased.

Less frequent causes of death included ileus, thrombo-embolism, intestinal obstruction, chronic, sepsis, lung abscess, liver abscess, subphrenic abscess, gas bacillus infection, hemopneumothorax and meningitis. All these complications were managed by the methods usually employed in civilian practice.

The Second Auxiliary Surgical Group, which saw active service in Italy, France and Germany, treated more than 3,500 abdominal wounds with a gross mortality for the surgical cases of 25.5 per cent.[23] From the 38th Evacuation Hospital, which also saw active service, Imes[24] recorded a mortality of 20 per cent for 358 abdominal injuries treated surgically. Bradford and Campbell[25] reported a mortality of 16.7 per cent for 443 operations, while Rohlf and Snyder[26] recorded the extraordinarily low mortality of 11.9 per cent in 67 cases.

THE APPLICATION OF MILITARY EXPERIENCES TO CIVILIAN SURGERY

The military experiences of World War II proved clearly that the mortality of penetrating wounds of the abdomen can be lowered drastically by proper surgical procedures. There seems no reason why similarly good results should not be achieved in civilian surgery for the same conditions. It is true that in the Army, surgeons were dealing with young, healthy adults, in the prime of physical condition, though that advantage was frequently offset by the fact that the men were tired, often to the point of exhaustion, that they were dirty, that in some instances they had not bathed for weeks, that they were likely to be dehydrated, and that frequently they were none too well nourished because they had lived on limited rations, sometimes for long periods of time. Moreover, many other circumstances were unfavorable, including difficulties of transportation, often under enemy fire, hospitals that, however well equipped, were necessarily makeshift, and personnel that was frequently in short supply.

An analysis of abdominal injuries in civilian practice reveals, on the other hand, numerous favorable factors. Most patients who suffer this type of injury are young adults, who are seldom more than 40 years of age. They are likely to be physically active. They live in city districts, where ambulance service is prompt, hospitals are near at hand, and medical supplies and personnel are plentiful.

That a gratifying decrease in the mortality of abdominal injuries can be achieved in civilian practice has already been demonstrated. In 1944 Sloan[27] reported from the Johns Hopkins Hospital a mortality of 14.3 per cent in a

series of 59 cases treated after 1939, when the plan of treatment was changed and when, in particular, transfusion was used frequently and chemotherapy was employed routinely. In 1947, at Grady hospital in Atlanta 62 cases of perforating rifle- and pistol-shot wounds were treated surgically with only 11 deaths, 17.7 per cent.[28] There seems to be no good reason why similar or better results should not become the rule.

CONCLUSION

The results achieved in abdominal injuries in World War II have never been surpassed in the history of surgery and have been equalled only in small series of selected cases treated by highly skilled surgeons. There is ample credit for all who participated in this achievement, but the young men who performed the bulk of the operations deserve the bulk of the credit. The skilful surgical technic and the brilliant surgical judgment exercised by them at the operating table established for all time the value of the residency system which had come to full flower between the wars. It was here that these young men demonstrated how well they had learned the lessons which they had been taught.

Gordon-Taylor,[21] whose experience in World Wars I and II probably surpasses the military experience of any living surgeon, paid them a tribute with which I might well conclude this paper:

Ideals may be for pursuit and not for attainment, but he would be bold indeed who ventured to foretell that in this province of surgery the zenith of our achievement has yet been attained; already, indeed, the recovery-rate in the hands of a few individual surgeons, whom Luck has perhaps brushed with her wings, or who may have been blessed in the matter of environment or fortunate in other ways, has been of almost astronomical magnitude. There is much, therefore, to substantiate the claim of the young surgeon that in the treatment of abdominal casualties of war he has surpassed his teachers and the previous generation of war surgeons.

Macte virtute, puer, esto. Sic itur ad astra.
Well done, young man. That is the way to glory.

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Discussion.—Dr. Pat R. Imes, Louisville, Ky.: As Dr. Poer indicated, the greatest mortality factor in abdominal injuries in World War II was shock. Because of its importance and frequency in such injuries, the greatest benefit resulted from readily available whole blood which the Services provided for their care. I believe such availability of blood in civilian practice will show comparable improvement in the results. A review of the records of 53 patients admitted to the Louisville General Hospital because of abdominal trauma during 1946 showed that there were 15 deaths; two before surgery, five on the operating table and five within 24 hours following the operative procedure. I feel that these 12 of the 15 deaths might be attributed directly to the presence of shock. I also found that, in spite of our war experience, we were utilizing an average of 625 cc. of blood preoperatively and during the operative procedures, an obviously inadequate amount.

Regarding the policy of exteriorization of colonic wounds, there was not uniform agreement on this subject during the war. I did not feel that it should be practiced routinely and some of the British toward the end of the war likewise indicated their preference for primary closure in selected cases. On reviewing our experience in the Mediterranean theater, we were able to collect 168 cases who had primary suture of the colonic injury with a mortality rate of 24 per cent, which not only compared very

favorably with that following exteriorization (35 per cent in 945 collected cases), but effected a greatly improved morbidity record.

DR. AMOS R. KOONTZ, Baltimore: I would like to cite one instance of what an enterprising doctor can do under adverse circumstances, and without the benefit of modern knowledge. Dr. Poer's mention of the Greek soldier coming in carrying his intestines in his apron, in the time of Agamemnon, reminded me of this. Some years ago I had occasion to write a paper on traumatic rupture of the diaphragm, and in looking up the literature I came across Holmes' System of Surgery in the Medical and Chirurgical Faculty Library in Baltimore. This work comprised three volumes, and was published about 1870. The chapter on gunshot wounds was written by Dr. Hunter McGuire, who had been chief surgeon of the Second Corps of the Army of Northern Virginia, commanded by Stonewall Jackson. Dr. McGuire probably at that time knew more about gunshot wounds than any other man living. He had seen thousands of them in both Federal and Southern soldiers. Dr. McGuire made a reference to a case handled by two Doctors Amiss, which excited my curiosity, as I came from the same county in Virginia from which these doctors hailed. The doctors were Drs. Thomas B. and William H. Amiss. Mr. Fred Amiss, the son of Dr. T. B. Amiss, was still living in Luray, Virginia, so I wrote to him and asked if he knew anything about the case mentioned by Dr. McGuire. He wrote me substantially the following account of the incident:

Just after the battle of Cedar Mountain in 1862, Jackson's corps was on the march along a country road covered with about six inches of dust. The two Doctors Amiss, riding along this road, came across an officer lying beside the road. Superficial examination disclosed the fact that he had been disemboweled by a shell fragment, and his intestines were lying out on the ground, without any perforation, however. Cavalry, infantry and artillery had been marching along this road, so that the intestines were covered with a very thick coating of dust. One of the two doctors said to the other—"I reckon the only thing we can do with this fellow is to dig a hole and roll him into it." The wounded officer, much to their surprise, was conscious, and replied as follows—"If you damned doctors would do something for me I would get well. I had a hound dog who ran a mile once with his guts out. I sewed him up and he got well. I am as good as a hound dog, am I not?" The doctor then said—"This fellow is full of sand and grit in more ways than one, so we will see what we can do for him." They then had him moved to a nearby farm house, where they made up some salt solution, washed off his intestines, put them back into the abdominal cavity, and sewed up the wound. In three months the officer was back on active duty again. The officer was Colonel Snowden Andrews, of Baltimore, and the incident is briefly referred to in a footnote in one of the three volumes of Lee's Lieutenants, by Dr. Douglas Freeman.

MR. GUY BLACKBURN, Guy's Hospital, London, England: I am very much interested in the subject of this paper, and would like to congratulate Dr. Imes on his contribution. It takes me back to a Surgical Conference held in Rome in 1944, attended by British and American surgeons in the Mediterranean theatre, and presided over by Colonel Churchill. Wounds of the colon formed one topic of discussion, and one surgeon after another gradually confessed to intraperitoneal suture without exteriorization. At this time this was regarded by those in authority as unwise, but experience showed that it was safe in properly selected cases. For my own part I found exteriorization of the right side of the colon very unsatisfactory indeed, and went to any length to avoid it.

Like the other speakers, I have seen eventration of abdominal viscera, but I believe it to be prognostically of good significance. If viscera are immediately protruded and cannot be reduced spontaneously, it implies that the wound of entry is a small one. It is commonplace too that the intestinal damage in these cases is nearly always in the extruded gut without any intraperitoneal injury. Resection is usually necessary but results justified it.

Lastly, I should like to say one word about figures, and the folly of trying to com-

pare them in the two World Wars. Circumstances were so different, the types of wounds were quite different, the missiles were not the same. The principle was also recognized of bringing the surgeon to the wounded man, and not the wounded man to the surgeon. Operations, therefore, were done on the whole much earlier but not, I am sure, with any more technical skill. Nobody publishes rejection rates, and mortality rates without them mean nothing. Another factor, almost impossible to assess, is the interdependence of associated wounds, which account for as much as 15 per cent difference in complicated and uncomplicated abdominal injury.

I would end, Sir, by thanking you for your kindness in having me here, and Dr. Blalock in particular for asking me to such a delightful meeting of the Southern Surgical Association.

Dr. David Henry Poer, Atlanta, Ga. (closing): I appreciate very much the remarks of all the discussors. I am sure there are no real points of argument because the desire of all of us is the same, viz., to continue our efforts to lower the morbidity and mortality of this common type of injury, both in civilian and military experience.

Our civilian experiences were carried into the army, and now we want to reverse the procedure and bring back the things we learned in the army to our civilian work. In dealing with such a large number of cases many methods of treatment were carried out and we are now in a position to choose the ones that produced the best results.

I am familiar with Dr. Imes' experience in the 38th Evacuation Hospital where some primary sutures of colon injuries were done, and as mentioned by Mr. Blackburn, other surgeons in the British Army did the same with good results, but I think on the whole that in dealing with such a large number of surgeons of varying ages, experience and judgment, it was better to follow the policy of exteriorization, and the over-all mortality figures prove that right. Mr. Blackburn's comments regarding the advisability of doing a primary resection for injuries to the right colon are in agreement with our experiences.

In conclusion, I believe that the high mortality for perforating wounds of the abdomen which exists in most of our large city hospitals today is due to the following factors: (1) inadequate treatment of shock; not enough blood is given and treatment is not continued long enough after operation; (2) patients with active and profuse hemorrhage are treated for shock for too long before operation—operation must be started promptly in such patients; (3) chemotherapy is frequently inadequate, and (4) too much major surgery is put in the hands of a young and inexperienced house staff, with resulting prolongation of the operation and mistakes in judgment. The cure for these is obvious and within the reach of all of us.

NOTICE

The ANNALS OF SURGERY takes pleasure in printing the program of the Second Annual Meeting of the SOCIETY FOR VASCULAR SURGERY. The objects of this society are to promote the study and research in vascular diseases, to define more clearly the role of surgery in these diseases, to pool the experience and knowledge of its membership, to standardize nomenclature, to promote and encourage adequate teaching of these diseases to students, interns and residents, to encourage hospitals to develop special sections in vascular surgery and to provide special training for young surgeons interested in this field. Because of the recent rapid advances in this field, it is thought that many members of the surgical profession may be interested in attending the Meeting of this Society.

THE SOCIETY FOR VASCULAR SURGERY
Second Annual Meeting
Stevens' Hotel, Chicago, Illinois
Sunday, June 20, 1948

MORNING SESSION

1. **Allen, Arthur, W.**—President's Address
   Present Evaluation of the Prophylaxis and Treatment of Venous Thrombosis and Pulmonary Embolism.
2. **Homans, John,**
   The Management of Recovery from Venous Thrombosis in the Lower Limbs.
3. **De Bakey, Michael E. and Ochsner, Alton,**
   Gangrene as a Complication of Thrombophlebitis. Case Report and Review of the Literature.
4. **Beck, Claude S.**
   Revascularization of the Heart.
5. **de Takats, Geza,**
   The Cortico-Adrenal Factor in Essential Hypertension.
6. **Pearse, Herman, E.**
   Cellulose and Cellophane Products in Vascular Surgery.

AFTERNOON SESSION

1. **Elkin, Daniel E. and (by invitation) Cooper, Frederick, W. Jr.**
   Radioactive Isotopes in the Investigation of Vascular Disease.
2. **Veal, J. Ross.**
   The Surgical Treatment of Hyperhidrosis.
3. **Coller, Frederick and (by invitation) Campbell, Kenneth N., Harris, Bradley and Berry, Robert, E. L.**
   An Evaluation of Lumbar Sympathectomy in Far Advanced Arteriosclerosis Obliterans.
4. **Smithwick, Reginald H. and (by invitation) Whitelaw, George P.**
   The Effect of Sympathectomy upon Heart Rate and Possible Therapeutic Applications.

5. **Herman, Louis G. and (by invitation) Buchman, Joseph A.**
   Complications Resulting from Injuries to Arteries.
6. **Blakemore, Arthur H.**
   Portacaval Anastomosis for Portal Hypertension—Follow-up Results.
7. **Gage, Mims**
   Cardiac Decompensation Secondary to Arteriovenous Fistula with Report of Two cases.
8. **Freeman, Norman E.**
   A Technique for Division and Suture of the Patent Ductus Arteriosis in the Older Age Group.
9. **Linton, Robert R.**
   The Arteriosclerotic Popliteal Aneurysm. Treatment by Sympathectomy and Aneurysmectomy.